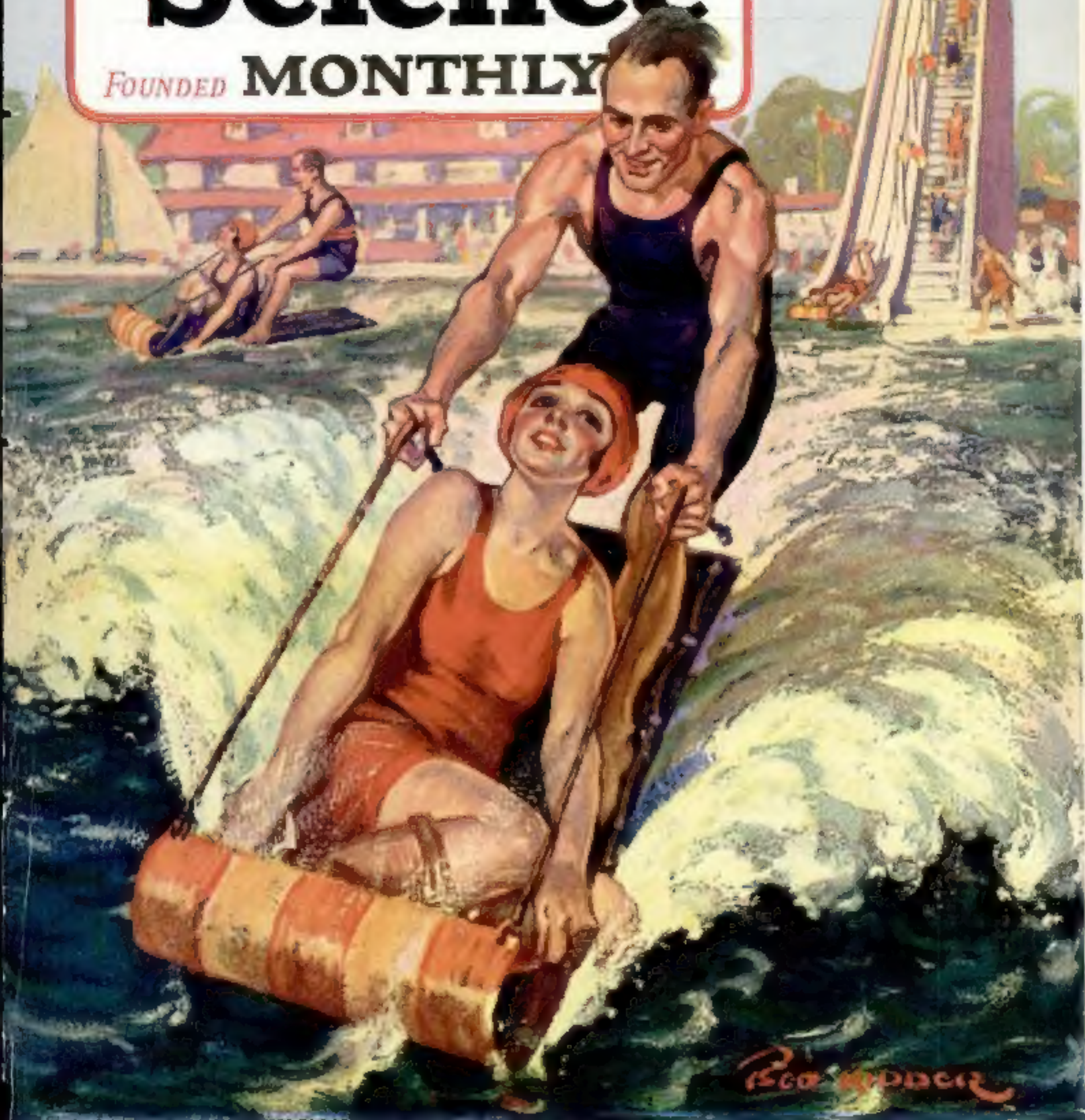


JACK BINNS' RADIO DEPARTMENT

Popular Science

FOUNDED MONTHLY



BOB HOPPER

Sixty Miles an Hour on New Water Toboggan (See page 23)

Can Deep Sea Divers Salvage Lusitania's Treasure?

AUGUST

New Ideas and Special Prizes for Tool Users

25 CENTS



Let Fatima smokers tell you

*Always slightly higher in price than
other Turkish brands but
just taste the difference*



An Amazingly Easy Way to Earn \$10,000 a Year

Let Me Show You How Free

TO the average man the \$10,000 a year job is only a dream. Yet today there are a surprising number of men earning five figure salaries who were merely dreaming of them a short while ago. The secret of their success should prove a startling revelation to every ambitious man who has ever aspired to get into the \$10,000 a year class.

There is nothing fundamentally "different" about the man whose salary runs into five figures. He is made of the same stuff as you and I. It is not necessary that he must enjoy the privilege of some influential connection or "pull". For example take J. P. Overstreet, of Dennison, Texas. A few short years ago he was a police officer earning less than \$1,000 a year. To-day his earnings are in excess of \$1,000 a month—more than \$12,000 a year. C. W. Campbell, Greensburg, Pa., was formerly a railroad employee on a small salary—last month his earnings were \$1,562.

Why Salesmen Earn Such Big Pay

Just stop a moment and think over the successful men of your acquaintance. How many of them are connected with some form of selling? If you will study any business organization you will see that the big jobs go to the men who sell, for upon their efforts depend the profits a company makes. Without trained men to place a product on the market, the finest goods are worth no more than so much clay. Salesmen are the very nerve centers of a business. Is it any wonder that they earn big pay?

The man who starts working as a bookkeeper or clerk for \$25.00 a week never increases his value to the firm. Any advance in pay is merely a reward for length of service. At the end of ten years he is no more essential to the life of the organization than he was at the end of ten weeks. He is only a necessary liability—drawing his pay because somebody must be found to work at the unimportant, routine jobs. Once established in the rut, he becomes a cog in the machine—when he is worn out, he can be easily and cheaply replaced.

Why Don't You Get Into the Selling Field?

Mr. Overstreet, Mr. Campbell and the others whose letters you see on this page are all successful salesmen. They realized their ambitions by landing \$10,000 jobs in an amazingly simple way, with the help and guidance of the National Salesmen's Training Association. Sometime—somewhere back in the past, each one of them read of this remarkable course of Salesmanship training and Employment Service just as you are reading of it to-day. Each one of them was dissatisfied with his earning capacity—as perhaps you are—and each one cast his lot with the N. S. T. A. To-day they are important factors in the business world—enjoying all

the comforts and luxuries money can buy. And yet they are not exceptions, for there are thousands of N. S. T. A. trained salesmen who are making big money, as we will be only too glad to show you if you will mail the coupon.

We Train You and Help You Land a Job

The National Salesmen's Training Association is an organization of top-notch salesmen and sales managers formed for the express purpose of training men in the science of successful selling. You do not need to know the first thing about selling—for the N. S. T. A. trains you from the ground up—gives you a complete insight into selling methods—in your spare time without making it necessary to give up

your present position until you are ready to begin actual selling.

In addition to this remarkably efficient course of training, the N. S. T. A. maintains a Free Employment Service to help its Members to jobs in the lines for which they are best suited. This in itself is of incalculable value, for it allows the prospective salesman to make a complete survey of the selling field and to select the work which most appeals to him.

Salesmen Are Needed—Now!

Get out of that rut! Work for yourself! Salesmanship is the biggest paid of all professions. Just because you have never sold anything is no sign that you can't. We have made Star Salesmen of men from all walks of life, with no previous selling experience. These men have jumped from small pay jobs to big selling positions and handsome incomes. The same training on which they founded their success is open to you. You can follow in their footsteps. Why don't you get in a class with men who make real money? Never before have the opportunities been greater. At least you cannot afford not to investigate the great field of selling and see what it offers you. It will only cost you a 2-cent stamp and the facts and proof you will receive will surprise you.

Free Book on Salesmanship

Just mail the coupon or write for our free illustrated Book, "Modern Salesmanship," which we will be glad to send without any obligation on your part. Let us prove to you that regardless of what you are doing now, you can quickly become a Star Salesman. Let us show you how you too can step into the ranks of these big money makers of business. See how easily you can learn this fascinating, big pay profession at home in your spare time. Learn what we have done for others and what we stand ready to do for you. Don't put it off until to-morrow—write us today. Every hour lost keeps you that much farther from success. Mail the coupon at once.

National Salesmen's Training Association
Dept. 15-K, Chicago, Ill., U. S. A.

National Salesmen's Training Association
Dept. 15-K, Chicago, Ill., U. S. A.

Please send me, without any obligation on my part, your free Book, "Modern Salesmanship," and full information about the N. S. T. A. system of Salesmanship training and Employment Service. Also a list showing lines of business with openings for salesmen.

Name.....
Street.....
City.....
Age..... Occupation.....

Read These Amazing Stories of Quick Success

Earned \$524 in Two Weeks

I have never earned more than \$60 a month. Last week I cleared \$106 and this week \$218. You have done wonders for me.—Geo. W. Kearns, Oklahoma City, Okla.

I Now Earn as High as \$100 a Day

I took your course two years ago. Was earning \$16 a week clerking. Am now selling many of the biggest firms in the U. S. I have earned more than \$100 in a day. You secured me my position. Our Sales Manager is a graduate of yours.—J. L. DeBorde, Chicago, Ill.

Earned \$1,562 in Thirty Days

My earnings for the past thirty days are \$1,562, and I won Second Prize in March, although I only worked two weeks during that month.—C. W. Campbell, Greensburg, Pa.

Earned \$1,800 in Six Weeks

As soon as I received a letter from you and your literature, I knew that I was on the right track and very soon after I applied for a position as a Salesman in one of the firms whom you informed me were in need of a Salesman and to whom you had recommended me. As soon as they received my application, which was by mail, they wired me to come for an appointment, which I did, with the result being that I sold my service to them in about thirty minutes, took a territory in Illinois and Wisconsin and made a success of it from the very first week.

From that time on I have been what might be termed as a "high pressure" Salesman, selling lines where nine out of ten Order Takers would fail. I have sold goods in a highly successful manner in nine or ten States, both North and South. My earnings for March were over \$1,500 and over \$1,800 for the last six weeks, while last week my earnings were \$1,800. I travel about one month out of the year, working five days each week.

The N. S. T. A. dug me out of a rut where I was earning less than \$1,000 a year and showed me how to make a success.—J. P. Overstreet, Dennison, Texas.

Popular Science Monthly

Vol. 101

AUGUST, 1922

No. 2

The March of Science

A RADIO novice entering a New York electrical supply store the other day said he wanted to buy "a couple of thousand ohms." Not so many years ago, missing information as to scientific terms and facts was excusable. It wasn't even particularly embarrassing. People got along very well with only a smattering of science. But the automobile, radio, and industrial progress of the day have changed all that. Today, science is vitally important in every man's life. Newspapers that once gave it a few lines, now give it columns.

A Whirling Airplane

SOME newspapers went straight up in the air the other day, with a despatch about a British helicopter that was also supposed to go straight up in the air and turn over, and do tricks like a pet poodle. Boher second cable despatches explained that the first despatch was all a mistake. Development of the helicopter remains, however, the most magnificent hope of aviation. A weird but promising type of helicopter, whirling rapidly around on itself as it flutters upward, is now the subject of experiments in France. It will be described next month in a fascinating article from our Paris correspondent.

Hot Enough?

THE hottest place on earth is going to be turned into a vacation resort! It's so hot there in the summer, that the top of a government thermometer, scaled to 190 degrees, blew off soon after installation. Read next month the gripping story of the white man who lives all the year round in this furnace where, 200 feet below sea level, the temperature reaches 160°!

Do You Know?

WHO spoke the first sentence transmitted by radio phone?

Who invented the crystal detector?

Don't miss the story of G. W. Pickard, an unsung genius of radio history, told in the next issue of POPULAR SCIENCE MONTHLY.

Radio's Greatest Marvel

ENTERTAINMENT from distant broadcasting stations that you never before hoped to reach will be yours for the tuning—on an indoor loop aerial at that—if amazing prophecies about the latest wonder of radio come true. E. H. Armstrong, young wizard of the feed-back circuit, has "done it again." What Armstrong's new "super-regenerative circuit" really means in the history of radio is sketched by E. L. Bragdon on page 22 and by Jack Binns on page 76 of this issue. It is an essential bit of radio news of the hour that you can't afford to miss.

"Jack Binns Says"

A MORE detailed explanation of the new Armstrong invention and how it is likely to affect every radio fan's future has been written by Jack Binns for the September issue. What Jack Binns says about radio is the source whence hundreds of thousands of interested followers now draw their most up-to-the-minute information. Jack Binns has some unusually interesting radio news—and helpful advice—for you next month.

Oil Worries

THEY are still debating whether oil wrecked the Genoa conference. You can't debate the statement that oil—or the lack of it—has wrecked many a good car. Not till the oil film breaks does your depreciation account begin to look ominous. But it breaks quickly. The state of the oil in the crankcase is one of the great worries on the national motoring mind today. Thereby hangs a big story. One auto repair man kept a detailed record of 10,000 jobs—and traced the cause of so many of them to lubrication troubles that he set out to make the perfectly lubricated car. It cost him \$10,000 to manufacture—chassis alone. That sum measures the importance of lubrication. You'll find in Harold F. Blanchard's article on oil next month, as in his article on auto springs in this issue, not only useful information, but remarkably interesting reading.

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POPULAR SCIENCE MONTHLY
225 West Thirty-ninth St., New York City
Issued monthly. Single copy, 25 cents. Yearly subscription for any part of the world, \$1.00.
Advertising rates on application. Entered as second-class matter Dec. 28, 1915, at the Post Office at New York under the act of March 3, 1879. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A.
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Your Radio-Knowledge Worth Big Money

MANY amateurs are so absorbed in the fascinating fun of radio that they do not realize the big opportunities awaiting them in the commercial field. Thousands of men operating amateur stations have never considered that they can earn amazingly big salaries doing the same easy, interesting work.

Radio Amateur, don't waste your knowledge of Radio. Don't use it only as a lad or a hobby. Radio is more than that. It is a gigantic, six-billion-dollar industry—and growing bigger every day! Hundreds of commercial stations are in operation today; thousands more are being erected. Nearly every vessel on the seas is a floating radio station. Hundreds of manufacturers, thousands of stores, millions of people are interested in this great, new, marvelous industry!

Trained Men Needed Now

Do you realize what this worldwide expansion means to you? Many land radio interests employ a force of a thousand or more Radio men. Every vessel needs from one to three operators. Schools, stores, factories, newspapers and cities need operators, demonstrators, salesmen, instructors, technicians, designers, inventors, engineers. Everywhere you turn you see the tremendous demand for more trained certified Radio-technicians.

Here is your greatest opportunity for fortune and success. Take advantage of it. Radio needs YOU NOW! Get into this fascinating profession. The field is uncrowded. Jobs are literally going begging for competent trained men. The pay is big, and the work fascinatingly easy.

"Cash In" On Your Knowledge

Don't be a stay-behind. Don't let the other fellow beat you to the wonderful positions now awaiting for you in Radio. Make Radio a profession—not a plaything. Don't let your Radio-knowledge go to waste. "Cash in" on it—Big!

Thousands of men with no knowledge or experience now, are preparing for wonderful careers in this great profession. Will you allow these beginners to get ahead of you? Will you let them get all the big jobs while you sit idly by? Will you always be satisfied with being just an extra-good amateur when it is so easy to earn big money as a professional Radio-technician?

"Radio Headquarters" Will Help You

The knowledge you have now of Radio operation and maintenance makes it easy for you to train yourself and obtain a wonderful position. You can work up to positions paying as high as \$10,000 a year. If you are attracted by the adventure and excitement of travel, Radio offers you a glori-

ous opportunity to see the four corners of the earth, with all expenses paid and a fine salary besides, or you can stay at home and take one of the fine positions all around you.

Use your present Radio experience to help you achieve a wonderful success in this great field. America's "Radio Headquarters," the National Radio Institute, has devised an amazing new plan that will complete your Radio education in spare time at home, and enable you to qualify for a Government Commercial operator's license so you can take your place in the Radio profession in the shortest possible time.

One of the features of this remarkable course, which is approved by the Government, is that you are furnished free with four wonderful instruments for practical work at home. Among them is the wonderful Natrometer which quickly helps you acquire expert speed and accuracy in sending and receiving code.

In addition to this splendid, simplified short-cut course and the four patented instruments, nationally known Radio experts are your instructors. They correct your papers, give you the advice you seek, help you in every way with their wide experience to become a successful Certified Radio-technician.

Get This New, Free Book

The National Radio Institute is ready to give you the same practical help that has put hundreds of its graduates on the highway of Radio success. Read the letters in the panel from just a few of our 6000 students and graduates. You have the basic knowledge now.

Just a part of your spare-time spent in learning the professional side of Radio, will qualify you for your career in this field of unparalleled opportunities.

Radio is paying enormous earnings to men all over the country today—it is making hundreds of men wealthy. Find out at once about your opportunity in Radio. Send for the interesting big Book which tells all about the future waiting for you in this great field, and gives complete details of the plan by which the National Radio Institute prepares you quickly in your spare time to become an expert Radio-technician and helps you through its Free Employment Service to a good Radio position. Mail the coupon, or write a letter NOW!

NATIONAL RADIO INSTITUTE
Radio Headquarters
Dept. 1191,
1345 Pennsylvania Ave., N. W.
Washington, D. C.

NATIONAL RADIO INSTITUTE
Radio Headquarters,
Dept. 1191,
1345 Pennsylvania Ave., N. W.
Washington, D. C.

Please send me your free book telling how I can become a Certified Radio-technician in my spare time at home, with details about the positions open to me in Radio.

Name.....Age.....

Address.....

City.....State.....

The National Radio Institute Can Help You As It Helped These Men

N. R. I. Graduate a Radio Engineer

I believe your course in Radio Telegraphy and Telephony operation to be the best and most complete on the market today. I feel more than confident that any student taking your course and applying himself should have no trouble in passing the government examination. I myself am a graduate of your school.

R. J. DICKINSON, Radio Engineer,
Hamilton, Ohio.

No Course More Complete

No course could be more complete, more clear to the beginner. Besides giving a comprehensive study in Radio, the N. R. I. course practically covers every branch of electrical phenomena. As N. R. I. graduate has a wide and useful knowledge that cannot but be of use to him in any line of electrical work.

NATHAN V. LLOYD,
Babson, Washington.

Easy to Get Good Job

Only a short letter to let you know that I am still on board and waiting for the ship to sail. Tell your students for me that a man with a license had no trouble obtaining a good position. Believe me, a job like this is worth a good deal of studying.

J. M. WATSON, Jr.
S. S. "Lake Puffer," Norfolk, Va.

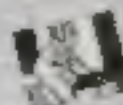
Course Superior to Others

I will say that the training I received from you and the careful instructions have enabled me to thoroughly understand Radio. The Natrometer is a great help to one who wishes to receive the code fast. The course is superior by far to any other that I know of.

WILLIAM
FARMER,
Lawrence, Mass.



HOW TO LEARN
RADIO
AT HOME



QUICK-ACTION ADVERTISING

HERE READERS AND ADVERTISERS MEET TO TRANSACT BUSINESS

Rate 25 Cents a Word. Advertisements intended for the October issue should be received by August 1st

AUTOMOBILES AND ACCESSORIES

PATENTS—Write for free Illustrated Guide Book and Evidence of Conception Blank. Send model or sketch and description of invention for our opinion of its patentability. Highest references. Reasonable terms. Victor J. Evans & Company, 189 Ninth, Washington, D. C.

AMERICAN Garage & Auto Dealer publishes each month interesting and helpful suggestions and information on sales, merchandising, advertising, business management, accounting, welding, cutting, brazing, practical and progressive hints for sales and shop, for "small-town" automotive dealers, garages, repairmen, mechanics. Subscription price \$1.00 per year. (Money back if not satisfied.) Sample copy on request. American Garage & Auto Dealer, 1006 Lake View Building, Chicago.

WEATHER-PROOF your car. Apply Tepee Liquid Auto Glaze with a chrome cloth. It dries leaving a dust-free, hard, rich, lustrous finish. Mud and water don't affect it. Being used everywhere. \$1.00 per can. Free. Road Chemical Co., Fourth, Montreal.

AUTOMOBILE Mechanics, Owners, Garages, Repairs, send for free copy America's Popular Motor Magazine. Contains helpful instructive information on overhauling, ignition wiring, carburetors, batteries, etc. Automobile Interest, 613 Butler Building, Cincinnati, Ohio.

FORD ACCESSORIES

FORD run 34 miles per gallon on cheapest gasoline or half kerosene, using our 1923 carburetor. Increased power, style for all motors; attach yourself. Money back guaranteed. 30 days' trial. Big profits to agents. Air Friction Carburetor Co., 5223 Madison Street, Dayton, Ohio.

SPREEDER Fans. See "Red-Kut" ad, page 106.

FORD Car Repair Book sent free. This complete, well illustrated, valuable book explains in a simple way the causes and cures of over-heating, repairing Ford timing, curing piston ring troubles, carburetor adjustments and repairs, connecting rods, transmission troubles, safe and repair of rear axle, stopping tail grease leaks; also covers practically every other phase of Ford car repairing. Send 25c coin for three months' trial subscription and get the valuable repair book free. Ford Owner and Dealer Magazine, 304 Montgomery Bldg., Milwaukee, Wisconsin.

FORD OWNERS—Keep your car looking neat and trim. Burnham's Flexible Tender Brass holds hood in current position, keeps them from sagging, lessens tire wear. Big money for agents. Send one dollar for sample and particulars. Burnham's Shop, Huntsville, Alabama.

ELECTRICAL

ELECTRICITY for 10¢ per hour. Motore auto generator. Operates on any make automobile. Produces electricity for moving picture machines, theatres, schools, churches, homes, etc. Write for free particulars. Monarch Theatre Supply Co., Dept. AG 714 Smith Washburn Avenue, Chicago.

WANTED

UNED Correspondence Courses wanted. All schools, all subjects. Courses bought, sold, exchanged. Bulletin 1000 free. Instruction Correspondence Exchange, 1904 Broadway, New York.

WANTED Representatives in every factory in the United States. Popular Science Monthly, 225 West 39th Street, New York.

WIRELESS

BUILD your own Radio receiver for \$5.00 and hear the concert nightly. Our blueprint No. 240 explains all. Price \$1.00. Experimenters Information Service, 45 Pinehurst Avenue, New York.

TOOLS AND SUPPLIES

12 TOOL handy set, made of best steel. The most useful and practical tool on the market. Free. National Speculator, 127 Union Square, New York City.

DUPLICATING SERVICES

"MODERN" Duplicators save Time, Labor and Money. Get Business, Reproduction Typewriter or Pencil Letters, Drawings, Letters, Music, Manus, Bids, Notices, Specifications, Maps or anything in one or more colors. Prints TWI per minute. Special Sale Co., 30 Days Free Trial. \$5.25 up. Booklet Free. J. V. Durkin-Reeves Co., Pittsburgh, Pennsylvania.

TRADE SCHOOLS

DENTAL laboratory work quickly taught through individual instruction. Our graduates in great demand, earn \$1000 to \$1000 yearly. Earn while you learn. Send for Bulletin 4. McCarrie School of Mechanical Dentistry, 24 West Lake Street, Chicago.

EARN more money—Learn sign painting, scenic painting, shadow writing, auto painting, paper hanging, decorating, graining, marbling, at Chicago or at your home. Chicago Painting School, 157 West Austin Avenue, Chicago.

TELEGRAPHY

TELEGRAPHY—(Morse and Wireless) and railway signalling taught thoroughly. Big salaries, great opportunities. Oldest, largest school. All expenses low—can own large part. Canadian free. Lodge's Institute, Queen Street East, Valparaiso, Indiana.

MR. ADVERTISER—Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

ADDING MACHINES

FREE trial marvelous new adding machine. Adds, multiplies, divides, automatically. Work equals \$100.00 machine. Price only \$15.00. Speedy, durable, handsome. Five-year guarantee. Used by largest corporations. Write to-day for catalog and free trial offer. Lightning Calculator Co., Dept. C, Grand Rapids, Mich.

LABORATORY AND CHEMICAL SERVICE

YOUR problem solved for Five Dollars. Write me W. Hedges Richards, consulting chemist, Box 3402, Boston, Massachusetts.

OPTICAL GOODS

ULTRALENS microscope. Patents pending. Model with magnification gradually variable from 2,500 to 42,500 times. \$1.00. Others from 100 to 250,000 times. Some-thing new. Circulars 8-7 free. Specialty Mfg. Co., Milton, Pennsylvania.

Are YOU Reaching This Vast Audience of Buyers?

These little messages of big business—the Classified Advertisements—receive consideration from interested people in every part of the world. And they are of sufficient importance to induce those people to respond in terms of dollars and cents. This statement is based on facts—voluntary letters of appreciation sent in by advertisers who KNOW the pulling power of a magazine that reaches a quarter of a million READERS every month.

A new advertiser has just written us as follows:

"Popular Science Monthly has brought answers from Mexico, Cuba, Canada, Hawaii and all parts of the United States. I think it covers a large territory and one that is profitable."

Of course it does. And YOU can cover that same territory—reach that same audience and transact real business by putting your message in the next issue. The rate is only 25 Cents a Word and the results will speak for themselves. Why not try it?

Classified Advertising Manager
POPULAR SCIENCE MONTHLY
225 West 39th Street
New York City

FORMULAS

FREE—Formula catalog. Laboratories, 4500 Boylston Building, Chicago.

1000 FORMULAS and recipes—400 pages. \$1.00. Englewood Book Shop, 10210 South Winchester, Chicago.

FORMULA catalog free. C. A. Lutz, Apartment 241, York, Pennsylvania.

FORMULAS of the better sort. Write for our free catalog. Thos. D. Reed, President, 622 Main, Richmond, Virginia.

1,000,000 FORMULAS, Trade Secrets. \$2.00. Pompaill Co-Operative Service Bureau, 7432, Kokomo, Indiana.

ABSOLUTE Money Centers! New catalog of novel, startling propositions free. Fitzgerald Laboratory, Box 49-E, Stapleton, New York.

MR. ADVERTISER—Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

RADIO SUPPLIES

BUILD your own radiophone. Instruction book ten cents. Radio Service Institute, 14th and U Streets, Washington, D. C.

RADIO Handbook. Simply explains crystal and vacuum tube receivers, stages of amplification, defines radio terms, gives everyday formulas, broadcasting stations, etc. Price 75 cents postpaid. Radio Service Bureau, 1431 Clifton Street N. W., Washington, D. C.

RADIO cabinets—(except post prepaid). Blade of seasoned wood, front radiated to receive panel, top hinged, knock down, screws included. In 81 panel 6 x 7, \$1.50; 6 x 10, \$2.00; 6 x 14, \$2.50; 6 x 21, \$3.25; 6 x 28, \$4.00; 6 x 35, \$4.75; 12 x 21, \$7.75. Finished in oak, mahogany, walnut, ebony. 50 cents extra. Prompt shipment. H. N. McClelland, Chesapeake, Virginia.

BUILD radio sets. We supply parts or complete units. Catalog 15 cents. Easily understood assembly drawings. Crystal detector set, non-regenerative receiver, regenerative receiver, 2 step amplifier, 25 cents each. All five \$1.00. No stamps accepted. Hatfield Airplane Company, Oswego, New York.

GALENA Crystals. See page for a hint of "Galeas" Galeas—enough for 5 or more detectors. Also supplied in bulk or granules. Discount to dealers. Harry J. Allen Co., 208 11 Post Street, Seattle, Washington. Distributors for Killbuck & Clark Radio Equipment.

AMATEUR—Material necessary to make set described in Popular Science. Stamp for catalog. Pacific Radio Co., 645 N. E. 52nd St., Portland, Oregon.

MANUFACTURING

LET us be your machining shop! We build models and will do your manufacturing. Victor Eng. Co., 2024 W. Chicago Avenue, Chicago.

MOTORCYCLES, BICYCLES, SUPPLIES

DON'T buy a bicycle motor attachment until you get our catalogue and prices. Shaw Mfg. Co., Dept. 4, Chelmsbury, Kansas.

SEND for big list of slightly used motorcycles on our easy payment plan. Howard Cycle Co., 102 N. Broad St., Trenton, New Jersey.

PARTS for all motorcycles cheap. Schuck Cycle Co., 1922 Westlake, Seattle, Washington.

USED and new parts. Indian, Excelsior, Harley, Henderson, Thrasher, Yale. Get our price lists. Kings Highway Cycle Co., 1165 North Kings Highway, St. Louis, Missouri.

MOTORCYCLE cylinders reground, fitted with new piston rings, \$1.00. Guaranteed. McBride Motor Co., Muncie, Indiana.

STAMPING NAMES

MAKE \$10.00 hundred stamping names on key chains. Send 25¢ for sample and instruction. PP Keytag Company, Colma, New York.

AMERICAN MADE TOYS

MANUFACTURERS wanted for large production and home-workers on smaller scale for metal toys and novelties: toy soldiers, cannons, cowboys, Indians, Buffalo Bills, wild animals, whistles, bird-whistles, race horses, prize-fighters, football players, put and take toys, and hundreds of other articles. Hundreds and thousands made complete per hour. No experience or other tools needed. House casting forms complete outfit from \$5.00 up. We buy these goods all year, paying fixed prices. Contract orders filled with manufacturers. Exceptional high prices paid for painted models. An enormous business for this year offers inducements than an excellent opportunity to enter this field. Write us only, if you mean real business. Catalog and information free. Metal Cast Products Co., 1080 Boston Road, New York.

INCREASE your output of metal toys and novelties by using a casting form feed machine. Write for circular T-6, V. G. Clute, Mechanicsville, New York.

AVIATION

INVENTORS desiring information write for our free Illustrated Guide Book and Evidence of Conception Blank. Send model or sketch of invention for our opinion of its patentability. Highest references. Prompt service. Reasonable terms. Victor J. Evans & Company, 151 Ninth, Washington, D. C.

MODELS AND MODEL SUPPLIES

WE make working models for inventors and experimental work, and carry a complete stock of brass gears and model supplies. Send for catalogue. The Pierce Model Works, Tinley Park, Illinois.

MODEL making and experimental work, modern shop, expert workmen. Manufacturing, Latent Model and Experimental Works, 625 W. Jackson, Chicago.

MODELS, dies, contract manufacturing. Modern shop. Lowest prices. Write for folder. Adams Fisher Mfg. Co., 151 St. Louis, Missouri.

FOR THE HOME

GRANDFATHER clock works, \$5.00. Build your own case, instructions free. Make good profits selling your friends. Clock works with chains for old or new cases. Write for full particulars. Clock Co., Newtown, Pennsylvania.

HEMSTITCHING and pinning attachment works on any sewing machine, easily adjusted. Price \$2.50 with full instructions. Oriental Novelties Co., Box 11, Corpus Christi, Texas.

FOR BOYS

PLAY North-Overs. Complete, easy instructor, 25¢. Dea, Publisher, Bowling Green, Ohio.

Quick-Action Advertisements continued on page 6

ANNOUNCING *The New* OLIVER



Now, in our 27th year, we introduce a new-day perfection in typewriters, a super-typewriter, one with an ancestry of 1,000,000 Olivers. It embodies many advancements, countless refinements. It is the climax of years of development.

We want everyone who is planning to buy a typewriter to become acquainted with this remarkable Oliver Speedster. Note our offer below. To see it, to operate it, brings a new appreciation of the ultimate.

The Oliver Speedster discards many old ideas, many limitations. It brings dozens of improvements which you will appreciate quickly. To own an Oliver Speedster—years ahead in design—means a new satisfaction.

No one now can afford to buy any typewriter without first investigating this advanced and wonderful Oliver, the finest, the most durable, the quietest model we've ever built.

SPEEDSTER

Our latest and finest model, No. 11

Save \$35

While we retain all the fundamental and proven features which have brought such fame to earlier models, and while we bring improvements not to be found elsewhere, we do not revert to the customary \$100 price.

The new Oliver Speedster, worth \$100 if any typewriter is, is sold from factory-to-you, at \$65, saving you the \$35 that it formerly cost to sell an Oliver.

Our policy, since 1917, has been to produce the finest typewriter possible at the lowest cost. We have eliminated extravagant, roundabout selling plans, and substituted the popular factory-to-you plan. The Oliver sells itself. It must prove that it is the finest, regardless of price.

Free Trial

We ship the new Oliver Speedster to you for five days free trial. That is the best way for you to become acquainted with its advancements. Use it as if it were your own. Note its superiorities. Compare it. See what the numerous improvements offer.

Then if you agree that it out-classes any typewriter on the market, and want to buy it, send us only \$4 after trial, then \$4 per month. If you do not want to keep it, ship it back at our expense.

This free trial does not obligate you to buy. It is part of our new plan. You are the sole judge. The coupon brings the Oliver, or further information. Check which you desire.

The Oliver Typewriter Company

1108 Oliver Typewriter Building
Chicago, Ill.



THE OLIVER TYPEWRITER COMPANY

1108 Oliver Typewriter Building, Chicago, Ill.

☐ Ship me a new Oliver No. 11 Typewriter for five days' free trial. Then, if I keep it I will pay \$65 as follows: \$4 at the end of trial period and then at the rate of \$4 per month. The title to remain in your name until fully paid for. If I make cash settlement at end of trial period I am to deduct from my cash and remit to you \$65.00. If I decide not to keep it, I will ship it back at your expense at the end of five days.

My shipping point is _____

☐ Do not send a machine until I order it. Mail me your book, "The High Cost of Typewriters—The Oliver and the Remedy," the Speedster catalog and further information.

Name _____

Street Address _____

City _____

State _____

Occupation or Business _____



"I Got the Job!"

"I'm to be Manager of my Department starting Monday. The boss said he had been watching all the men. When he found I had been studying at home with the International Correspondence Schools he knew I had the right stuff in me—that I was bound to make good. Now we can move over to that house on Oakland Avenue and you can have a maid and take things easy. I tell you, Neil, taking that course with the I. C. S. was the best thing I ever did."

Spare-time study with the I. C. S. is winning promotions for thousands of men and bringing happiness to thousands of homes all over the world. In offices, shops, stores, mines, mills and on railroads, I. C. S. trained men are stepping up to big jobs over the heads of older men, past those whose only qualification is long service.

There is a Job Ahead of YOU

Some man is going to be picked for it. The boss can't take chances. When he selects the one to hold it he is going to choose a trained man with sound, practical knowledge of the work. Get busy right now and put yourself in line for that promotion. You can do it in spare time in your own home through the I. C. S., just as nearly two million men and women have done in the last 30 years, just as 120,000 other men are doing today.

The first step these men took was to mark and mail this coupon. Make your start the same way!

INTERNATIONAL CORRESPONDENCE SCHOOLS

Box 7187-B, Scranton, Penna.

Without cost or obligation on my part, please send me full particulars about the subject before which I have marked an X in the list below—

BUSINESS TRAINING DEPARTMENT

- | | |
|---|---|
| <input type="checkbox"/> Business Management | <input type="checkbox"/> Salesmanship |
| <input type="checkbox"/> Industrial Management | <input type="checkbox"/> Advertising |
| <input type="checkbox"/> Personnel Organization | <input type="checkbox"/> Letter Writing |
| <input type="checkbox"/> Traffic Management | <input type="checkbox"/> Foreign Trade |
| <input type="checkbox"/> Business Law | <input type="checkbox"/> Stenography and Typing |
| <input type="checkbox"/> Banking and Banking Law | <input type="checkbox"/> Business English |
| <input type="checkbox"/> Accounting (including C.P.A.) | <input type="checkbox"/> Civil Service |
| <input type="checkbox"/> National Cost Accounting | <input type="checkbox"/> Railway Mail Clerk |
| <input type="checkbox"/> Bookkeeping | <input type="checkbox"/> Common School Subjects |
| <input type="checkbox"/> Private Secretary | <input type="checkbox"/> High School Subjects |
| <input type="checkbox"/> Business Spanish <input type="checkbox"/> French | <input type="checkbox"/> Illustrating |

TECHNICAL AND INDUSTRIAL DEPARTMENT

- | | |
|---|--|
| <input type="checkbox"/> Electrical Engineering | <input type="checkbox"/> Airplane Engines |
| <input type="checkbox"/> Electric Lighting | <input type="checkbox"/> Automobiles |
| <input type="checkbox"/> Mechanical Engineer | <input type="checkbox"/> Contractor and Builder |
| <input type="checkbox"/> Mechanical Draftsman | <input type="checkbox"/> Architectural Draftsman |
| <input type="checkbox"/> Machine Shop Practice | <input type="checkbox"/> Concrete Builder |
| <input type="checkbox"/> Railroad Positions | <input type="checkbox"/> Structural Engineer |
| <input type="checkbox"/> Gas Engine Operating | <input type="checkbox"/> Chemistry |
| <input type="checkbox"/> Civil Engineer | <input type="checkbox"/> Pharmacy |
| <input type="checkbox"/> Surveying and Mapping | <input type="checkbox"/> Automobile Work |
| <input type="checkbox"/> Mine Foreman or Engineer | <input type="checkbox"/> Agriculture and Poultry |
| <input type="checkbox"/> Steam Engineering <input type="checkbox"/> Radio | <input type="checkbox"/> Mathematics |

Name

Street Address

City State

Occupation

Persons residing in Canada should send this coupon to the International Correspondence Schools Canada, Limited, Montreal, Canada.

WE TEACH COMMERCIAL ART

Properly Trained Artists Earn \$10 a week and up. Meyer Both College—a Department of the Meyer Both Company—offers you a different and practical training. If you like to draw, develop your talent. Study this practical course—taught by the largest and most widely known Commercial Art Organization in the field with 20 years' success—each year produces and sells to advertisers in the United States and Canada over ten thousand commercial drawings. Who else could give you so wide an experience? Commercial Art is a business necessity—the demand for commercial artists is greater every year. It's a highly paid, intensely interesting profession, equally open to both men and women. Home Study Instruction. Get facts before you enroll in any school. Get our special booklet, "Your Opportunities"—for full the cost of mailing—in 10 stamps.

MEYER BOTH COLLEGE of COMMERCIAL ART

Michigan Ave. at 25th St.
Dept. 36, CHICAGO, ILL.

LETTER SPECIALISTS

JOHN CASH, 2009 Harvard Street, Houston, Texas. Letters, booklets, folders, trademarks, advertising. Lowest prices. Tell me your needs.

ASTROLOGY

HINDU astrology. Dr. Himbha, of Hoshiarpur, India, the world's greatest clairvoyant astrologer, tells your life story from the stars. Send date of your birth, 25c. stamp for trial reading. Dr. W. E. Himbha, P.O. Box 100, Virginia.

MAGIC words! Secret: new method of obtaining your desires. Postpaid for dime. Send only, 145 51st St., Brooklyn, N. Y.

HOROSCOPES

HOROSCOPE—complete—25c. Give birthdate. Bull, Station H, New York.

YOUR horoscope, character, friends, enemies, opportunities. Send name, birthdate and 10 cents (stamp) for test reading. Zenra, 205-B West 105th Street, New York.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

DRAWING INSTRUMENTS

ANNOUNCING The Golden Combination: Drawing built in one instrument—(cheapest and best outfit on the market). Already approved by the Indiana State Board of Education for its use in the schools. Write for free catalogue. Golden Compass Co., Elkhart, Ind.

OFFICE DEVICES

ADDRESSING machines, multi-graphs, duplicators, folders, check writers, sealers, dictating machines, at about half new cost. Frantz, 170-N North Wells, Chicago.

MISCELLANEOUS

EXCHANGE BOX, interesting letters through our Club. Send stamp. Betty Lee, 24 East Bay, Jacksonville, Florida.

EXCHANGE heavy letters with new friends. Lots fun. Send stamp. Eva Moore, P. O. Box 4309, Jacksonville, Florida.

SHAVE—without brush or soap. Skin left smooth and soft, guaranteed. Tube 50 cts. J. Clark, Washington, D. C.

10 DIFFERENT articles of Japanese beads for children for 25. T. T. T. Sakai Bros., Harajuku, Tokyo, Japan.

TATTOOING supplies. Illustrated catalogue free. Fred Waters, 1050 Randolph, Detroit.

EARN money taking orders for Rubber Stamps and Calling Cards. Good commission. Send ten cents for samples and terms. Rubber Stamp and Card Works, 901 Dorsey St., Clearfield, Pennsylvania.

ADVERTISING

FREE AD-Guide giving interesting rates for advertising in magazines and weeklies. Concordia Magazine, 217W, York, Pennsylvania.

ADVERTISE in 24 metropolitan dailies, 25 words, \$15. Helped Guide listing 1000 publications, 4c. stamp. Wade, Baltimore, Md., Chicago.

INCH Display Advertisements, 141 Magazine, 30c. \$15.00. Wood's Popular Services, Atlantic City.

SCENERY FOR HIRE

STREETSCENES for Operas, Plays, Musicals. Frank Brown, Catalogue, Amelia Griss, Philadelphia.

TYPEWRITERS AND SUPPLIES

TYPEWRITERS—all makes, \$15.00 up. Guaranteed five years, one month's free trial. Special proposition to agents. Send for catalogue before purchasing. Typewriter Manufacturers Exchange, Durham 217.

TYPEWRITERS. All makes. Save one-half! Thoroughly rebuilt in our factory by the famous "Young Process." Fully guaranteed. Free trial. We handle all standard makes. Cash or mail on easy terms. Write for catalogue. Young Typewriter Co., Dept. 205, Chicago, Illinois.

PICTURES AND POSTCARDS

"SURPRISE" friends. Four Rocky Mountains while staying home. 10 magnificent views 20 cents. Return for mailing. Great Fun. Hadler, 4053 So. Broadway, Denver, Colorado.

PRINTING, ENGRAVING, MULTIGRAPHING

LETTERHEADS, envelopes, 500 \$2.00. Samples free. Quality Printery, Marietta, Ohio.

100,000 1 x 2" labels, \$3.00. 1,000, \$1. Save 30%. Wall Labels, Station H, Philadelphia.

BETTER printing for less money! Send for our free package of samples of hundreds of items every user of printing is interested in. These samples worth dollars will be sent for 10 cents to pay postage. Ernest Farnus Company, 325 South Dearborn Street, Chicago.

EMBOSSED business, personal stationery. Samples, stamp. Daniels P. Company, Piquette, Pennsylvania.

1000 Letterheads or Envelopes, \$3.00, sent postpaid. Samples free. Monitor Press, Shamokin Building, Harrisburg, Pennsylvania.

POULTRY AND LIVE STOCK

BREED eggs. Book free. C. Rice, Melrose Highlands 77, Massachusetts.

Z. Y. SPENCER, Orchard Spencer Turkeys, P.O. Box 21, Santa Cruz, California. Booklet free.

BABY chicks. Cut price. Illustrated booklet. Empire Hatchery, Roseton, N. Y.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.



Play "JAZZ" on the Saxophone

Become musician so quickly as to astound everyone. Learn by playing real music—instead of tireless "exercises." You'll soon become the most popular person in your "set."

New Easy Method

is a revelation. Nothing else like it for thoroughness and rapidity. So simple that young and old find it easy to play with amazing skill. No "trick music"—but actual notes, learned quickly right in your own home.

Free Book

offers this wonderful musical opportunity. Send for it today before copies are exhausted. You'll be astounded, thrilled, fascinated, at this easy, rapid way to become a veritable master of your favorite instrument. Name below the instrument you are particularly interested in.

Learn to Play any Instrument

Piano	Mandolin
Organ	Drums and
Violin	Traps
Saxophone	Harmonica and
Clarinet	Composition
Flute	Sight Singing
Harp	Ukulele
Cornet	Piccolo
Cello	Trombone
Guitar	Saxophone
Automatic Finger Control	
Voice and Speech Culture	

U. S. SCHOOL of MUSIC, 20 Broadway Bldg., N. Y. City

Send me your amazing free book "Music Lessons in Your Own Home." This does not put me under any obligation. (Please Write Name Plainly.)

NAME

ADDRESS

INSTRUMENT

Learn Chemistry at HOME

Chemistry offers the greatest opportunities today of any profession. If you want to know how you can learn chemistry at home, in your spare time, write to one of the foremost authorities on Chemistry, Dr. T. O'Connor, Director, New York Chemical Institute of New York Home Extension Division, 140-N Liberty St., New York City. Dr. O'Connor will send you full information FREE, by return mail.

ARITHMETIC OF ELECTRICITY

A practical treatise on electrical calculations of all kinds reduced to a series of rules, all of the simplest forms, and involving only ordinary arithmetic. 200 pp. Price \$1.50.

POPULAR SCIENCE MONTHLY
225 West 39th Street 41 New York



Hotels Need Trained Executives

Nation-wide demand for trained men and women in all departments of hotels, clubs, and apartment houses. Uncrowded field, fine living, quick advancement in the big hotels of the United States—now America's Fourth Largest Industry. Statistics show that ONE IN EVERY TEN HOTELS WILL HAVE AN OPENING FOR A MANAGER THIS YEAR. Thousands of other positions also open to those who qualify through training.

The Lewis School guarantees to give you the valuable knowledge that it has taken some of the most successful hotel men years to obtain—men who are now making \$5,000 to \$50,000 a year. All of your training will be under the personal direction of Clifford Lewis—a hotel expert of national reputation. A few spare-time hours a week given to the simple, clear lessons of the course open the way to a good position, a fine living, and a handsome salary. The training will in no way interfere with your present activities.

Send today for FREE BOOK "Your Big Opportunity." Don't wait a minute—see how the opportunity of a lifetime. Mail the coupon NOW. Your whole future may depend on it.

Founded 1918
Lewis Hotel Training School
CLIFFORD LEWIS, Pres.

Room 2719
Washington, D. C.

Name

Street

City State



Get Into the Auto Game

Earn \$50.00 to \$100.00 a Week

Don't be content with an ordinary salary when you can get *big money* in the auto game. This is the biggest year in the history of the automobile industry. Thousands of men who know something about cars are needed to keep them in repair. Big jobs are open everywhere. Get into the game and open a garage of your own.

Partial List of Contents:

More than 100 Blueprints of Wiring Diagrams.
Explosion Motors.
Welding.
Motor Construction and Repair.
Carburetors and Settings.
Valves, Cooling, Lubrication.
Fly-Wheels.
Clutch.
Transmission.
Final Drive.
Steering Frames.
Tires.
Vulcanizing.
Ignition.
Starting and Lighting Systems.
Shop Kinks.
Commercial Garage.
Design and Equipment.
Electrics.
Storage Batteries.
Cars and Repair.
Motorcycles.
Commercial Trucks.
Tractors.

New Way to Learn Right at Home In Spare Time

Fifteen great automobile engineers and experts have made it possible for you to learn the automobile repair business without taking any time from your present work. This great library teaches everything that the best auto schools teach—at about one-twentieth of the cost. It lays the entire field of auto construction open before your eyes—explains everything about every make of car. Written in plain, everyday language—easy to read and easy to understand. Over 50,000 sets of previous editions have been sold. This is the new edition—the most up-to-date books on automobiles ever published.

Auto Books Six Volumes— Shipped FREE

You don't have to pay one cent in advance. Just mail the coupon and use the books for a whole week in your home or shop—then decide whether you want to keep them or not. If you like the books, send us only \$2.80 and \$3.00 each month until \$21.80 is paid. If you don't like them, just ship them at our expense and you won't owe us a cent. Mail the coupon now.

Don't Send Money! The coupon is all you need. See the books before you pay us anything. We guarantee that you will be satisfied with what you get. There is no risk on your part. Mail the coupon now.

American Technical Society
Dept. A-20c
Chicago, U. S. A.

Send the coupon now

AMERICAN TECHNICAL SOCIETY
Dept. A-20c, Chicago, U. S. A.
Please send me the 6-volume set of Automobile Engineering for 7 days' examination, shipping charges collect. If I decide to buy, I will send \$2.80 within 7 days and the balance of \$3.00 a month until the \$21.80 has been paid. Then you send me a receipt showing that the books are mine and fully paid for. If I think I can get along without the books after the 7 days' trial, I will return them at your expense.

Name _____

Address _____

Reference _____



A Big Raise in Salary

Is Very Easy to Get, if You Go About It in the Right Way

You have often heard of others who have doubled and trebled their salaries in a year's time. You wondered how they did it. Was it a pull? Don't you think it. When a man is hired he gets paid for exactly what he does, there is no sentiment in business. It's preparing for the future and knowing what to do at the right time that doubles and trebles salaries.

Remember When You Were a Kid

and tried to ride a bike for the first time? You thought that you would never learn and then—all of a sudden you knew how, and said in surprise: "Why it's a cinch if you know how." It's that way with most things, and getting a job with big money is no exception to the rule, if you know how.

We Will Show You How

Without loss to you of a single working hour we can show you a sure way to success and big pay. A large number of men in each of the positions listed are enjoying their salaries because of our help—we want to help you. Make check on the coupon against the job you want and we will help you get it. Write or print your name on the coupon and send it in today.

American School

Dept. C.C. 73, Drexel Ave. & 58th St., Chicago

American School

Dept. C.C. 73 Drexel Ave. & 58th St., Chicago
Send me full information on the subject checked and how you will help me win success.

- | | |
|-------------------------|------------------------|
| Architect | Lawyer |
| Building Contractor | Machine Shop Practice |
| Automobile Engineer | Photocopy Writer |
| Automobile Repairman | Mechanical Engineer |
| Civil Engineer | Ship Superintendent |
| Structural Engineer | Employment Manager |
| Business Manager | Steam Engineer |
| Cart. Public Accountant | Foremanship |
| Accountant and Auditor | Sanitary Engineer |
| Bookkeeper | Surveyor (and Mapping) |
| Draftsman and Designer | Telephone Engineer |
| Electrical Engineer | Telegraph Engineer |
| Electric Light & Power | High School Graduate |
| General Education | Fire Insurance Expert |
| Vocational Guidance | Wireless Radio |
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Name _____
Address _____

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1085 Michigan Avenue, Chicago

Electrical Engineering

men with training are in demand. For more than a quarter of a century, this school has been training men of ambition and limited time for the electrical industries. Condensed course in Electrical Engineering enables graduates to secure good positions and promotions. Theoretical and Practical Electricity, Mathematics, Steam and Gas Engines and Mechanical Drawing. Students construct dynamo, install wiring and test electrical machinery. Course with diploma complete

In One Year

Over 3000 men trained. Thoroughly equipped dynamo laboratories, dining hall, laboratories, shops.

Free catalog, 30th year begins Sept. 27, 1922

Winn Electrical School 402 Tabern Ave., Washington, D.C.

EDUCATIONAL AND INSTRUCTION

CORRESPONDENCE courses at less than half original prices. Any school any subject for men or women. Bulletin 1924 free. Used courses bought. Instruction Correspondence Exchange, 1905 Broadway, New York.

BOOKKEEPING in a week. (Drama, 1857-59) Walling Avenue, New York.

BOOKKEEPING taught in one day. Send \$2.00 for self-instructor. Arline Ledger and Income Tax Revised. Standard Systems Co., 220 So. State Street, Chicago.

DOUBLE entry bookkeeping mastered in 60 hours guaranteed. diploma. International Bookkeeping Institute, Springfield, Missouri, Desk 10.

LINCOLN-JEFFERSON University. Home study in Academy College. Theological, Law, Music, Pharmacy, Business and Graduate schools, leading to degrees. Box G, 84 W. Randolph Street, Chicago.

BECOME master dealer—Learn active real estate system. Big profits. Independence. Either sex. Guaranteed. Special offer free. Stephens system, 618 W. 12th, Muncie, Indiana.

LANGUAGES

WORLD-Romish system. Masterkey to all languages. Primers, 12 languages, \$1.95 each language: Arabic, Chinese, Danish, Dutch, English, French, German, Italian, Japanese, Punjabi, Polish, Portuguese, Russian, Spanish, Swedish. Pronunciation-Tables, 10 languages, 20c each language. Language Publishing Company, 8 West 41st Street, New York.

PHONOGRAPHS, RECORDS

BUILD your phonograph. Quality phonographs. Highest quality spring and electric motors, tone arms, reproducers, amplifiers, case material and accessories. Free blue prints and building instructions. Big saving. Wonderful results. New catalog mailed for ten cents. Humber Manufacturing & Supply Co., Phonograph Supply Department, 318 Baldwin Block, Indianapolis, Indiana.

BUILD your own phonograph. Write for prices of cabinets, motors and tone arms. Arthur Davis, Livingston, Illinois.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

GAMES AND ENTERTAINMENT

TRICKS puzzles, jokes, mind-reading acts, sensational stunts. 140-page catalogue, 10c. Oaks Magical Co., Dept. 430 Oakbrook, Wisconsin.

TRICKS jokes, magic, puzzles, joker's novelties. Catalog free. Clifford Fennel, 2401 Jefferson, Louisville, Kentucky.

CHALK TALKS

LAUGH producing program. \$1.00. Circulars free. Cartoonist Bards, Oakbrook, Wisconsin.

FOR SALE

6 VOLT electric lighting plants. Steam turbine drive. Flash boilers. Burners, etc. Holden, Colchester, New York.

WATCH REPAIRING

I CAN make your watch keep correct time. Swiss or American. Large or small. Get my estimate free, mailing box free on request. Jas. A. McKim, 101 W. 42nd St., New York.

FOR MEN AND WOMEN

GENUINE Indian baskets and wampum—wholesale. Catalogue. Gilham, Berkeley, California.

BE a detective. Excellent opportunity, good pay, travel. Write C. T. Ludwig, 434 Westover Bldg., Kansas City, Missouri.

SEXUAL philosophy, 12c. Clear, specific, authoritative, complete, best method. Fred H. Kammann, Lawrence, Massachusetts.

DETECTIVES—Excellent opportunity. Fascinating work. Experience unnecessary. Particulars free. Write American Detective System, 1905 Broadway, New York.

U.S. 12 correspondence courses. Bargain prices. Bulletin 1924 free. Courses bought. Instruction Correspondence Exchange, 1905 Broadway, New York.

ALCOHOL, Book 41. Formulas free. Hys. Rum Recipe \$2 bottle. Copper bottles. CARAT, Box 251, Boston.

HAIR grown on bald heads where fine hairy roots, \$40.00. Superb hair removed forever, \$5.00. Kathelion or money back. Knapp Bros, 262 W. West 7th Street, St. Paul, Minnesota. References: Commercial State Bank.

WORK WANTED

PUNCH Press work, tool and die making model, and special machine work wanted. Completely equipped with new machinery of the latest type. Prompt delivery, reasonable prices guaranteed. Quality & Machine Co., Dept. B, 6154-56 N. Clark St., Chicago.

CIGARS, CIGARETTES, TOBACCO

HOMESPUN smoking tobacco—5 lbs. \$1.00; 10 lbs. \$1.75; 20 lbs. \$3.25. Farmers Union, Mayfield, Kentucky.

BOOKS AND PERIODICALS

DISEASES, cause and natural cures. Remedy, 25c. Arthur Stevens, Watsons, Ohio.

STEVES—Nervelets mean new nerves for weakness, neurasthenic men. For free literature, write Oak Med. Co., West Hoboken, New Jersey.

MAKE your own rubber waf. Inexpensive, easy. Copyright book 50 cts. Swedley, 145 Miller, Brooklyn, New York.

RADIO. Reproduces music, lectures, news, etc. Ready made. Instructions 25c. "Hypnotism" another wonder. Lesson \$1.00. Science Institute, SP1014, Belmont, Chicago.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.



"Learn By Doing"

Every phase of all branches of

ELECTRICITY

taught by

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In America's foremost and oldest institution for trade training.

No Books Used

Individual instruction. Start Any Day

Write for FREE 64-page catalog

THE NEW YORK ELECTRICAL SCHOOL

48 West 17th St., New York City

"DON'T SHOUT"

"I hear you. I can hear now as well as anybody. 'How?' With THE MORLEY PHONE. I've a pair in my ears now, but they are invisible. I would not know I had them in, myself, only that I hear all right."

The Morley Phone for the DEAF

It is the ears that listen to the voice, invisible, comfortable, lightweight and hygienic.

Anyone can adjust it. Over one hundred thousand sold. Write for booklet and testimonials. 702 North 1st St., Dept. 191, 28 South 14th Street, Philadelphia.

LEARN ENGINEERING

Courses, 3 months to 2 years—practical—technical training under experts. Not a Trade School, but a practical technical college teaching electricity, steam, gas, auto-electric, structural welding, drafting. Retains the student and time. Degrees awarded. Day and night sessions. Small size time.

FINLAY ENGINEERING COLLEGE, 1002 Indiana Ave., Kansas City, Mo.

\$1,000 REWARD if this is your FINGER PRINT

If this is your Finger Print or if you can duplicate this Finger Print with an impression from any of your fingers or the fingers of any of your friends, you are entitled to this \$1,000 Reward. We make this offer to prove the accuracy of Finger Print identification. Your Finger Print may be the only one. Send for full, complete, FREE explanation how to make the test. We will tell you also about a position we have for you.

FREE GUARANTEED POSITION OFFER

Finger Print profession wants men. Big pay, interesting work, and certain income. We will tell you how you can qualify. Send at once as offer is limited. No obligation—and no cost to you.

U. S. SCHOOL OF FINGER PRINTS
Dept. 44-8 702 N. 1st St., Chicago

Automobile Repairshop Shortcuts

Contains over 1,500 time and labor saving methods and devices that have proven exceptionally helpful in repairing or adjusting engine clutches, gear-sets, running gears and bodies, etc., and in managing and equipping shops. Here is the opportunity to study the methods of over five thousand experts who were all striving to find a better way to do some job and to shorten the time required to do it. 1,500 illustrations. Price, postpaid, \$3.50

Motorcycles, Side Cars and Cycle Cars

Their Construction, Management, and Repair. By VICTOR W. PAGE. Describes fully all leading types of machines. 500 pp., 350 lbs., 5 folding plates. Price, \$7.00

POPULAR SCIENCE MONTHLY

225 West 39th Street New York

Earn Up to \$250 Per Month

Position GUARANTEED



BE A RAILWAY TRAFFIC INSPECTOR

Men Wanted!

SPLENDID OPPORTUNITIES for trained Railway Traffic Inspectors. Fascinating new profession; any average man can qualify. Healthful, outdoor work with something new every day. Travel or remain near home.

Start at \$110 per month, expenses paid; advancement rapid with experience. Meet big railway officials. **Earn up to \$250 and \$300 per month, expenses paid.**

YOU TAKE NO RISK

Prepare in 3 months' spare-time study at home. Position is then **GUARANTEED**; you, paying at least \$110.00 a month and expenses or your money is refunded. You take no chances; either you are placed in a position as Railway Traffic Inspector or the training costs you nothing.

Many more men are needed than are trained. You can easily qualify. Send for free Booklet No. D-729, giving full particulars.

Send coupon today while you think of it.

Standard Business Training Inst.
Buffalo, N. Y.



Send me, entirely free, Booklet No. D-729 giving full particulars about course in Railway Traffic Inspection.

Name _____
Street _____
City _____

FOR INVENTORS

INVENTORS If you have an idea before spending money for a patent, write a letter to each agent. We will tell you if it is worth the cost of a patent. Write: **Matthew M. Stettin, Patent Attorney, 1111 14th St. N.W., Washington, D.C.**

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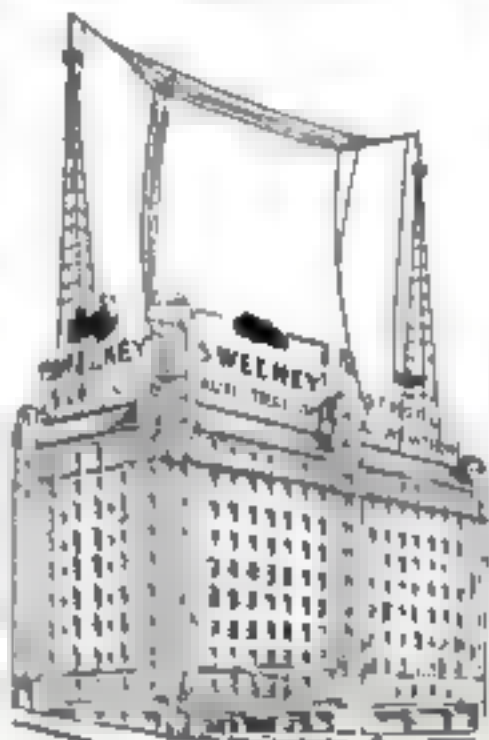
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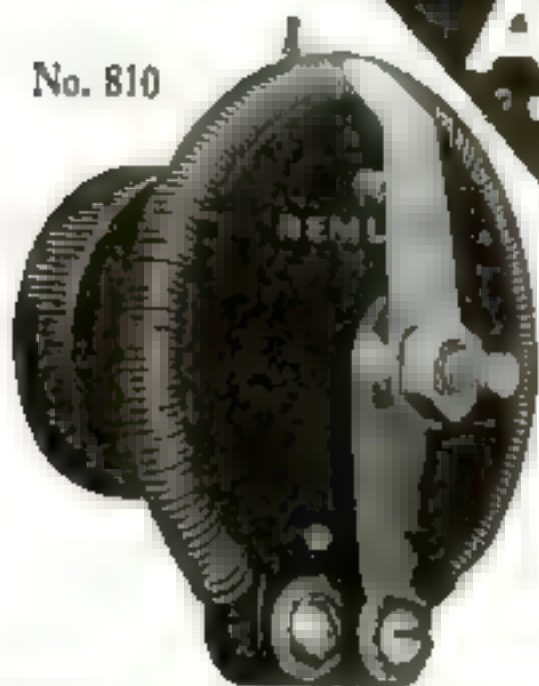
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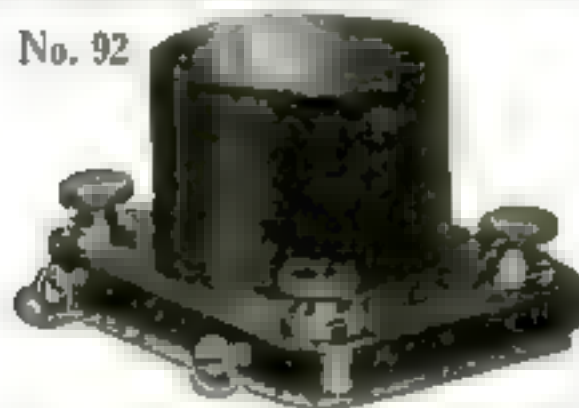
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Can Divers Raise the Lusitania's Gold?

*New Diving Armor, Deep Sea Camera, and Submarine Tractor
Among Recent Inventions for Spectacular Salvage Trips*

CAN the millions supposed to lie in the Lusitania's strong room be salvaged?

Can the Lusitania herself be raised?

Or is that historic tomb of nearly 1200 submarine victims now only a vast, sand-covered pile of shattered wreckage?

Answers to these questions and, in addition, the opening of a romantic era of deep-sea treasure hunting may hinge on a dramatic contest, this summer, between rival salvage expeditions over the Lusitania's grave.

In the more than seven years that have passed since her fatal voyage, no human has attempted to probe the depths where the Lusitania lies. But since her name grips the popular imagination as the most ghastly of all reminders of U-boat warfare, recent news of apparently bona fide efforts to probe the great vessel's remains has aroused much interest throughout the world.

Which Will Win?

Remarkable ingenuity in deep sea diving methods and extraordinary new inventions to permit men to explore decks and cabins at unprecedented depths, will be used in this summer's projected salvaging operations.

Even as this article is written, one expedition, led by Benjamin E. Leavitt, is sailing from Philadelphia, staking its hope on the use of unique diving suits, designed for safety and freedom of action at great depths. Another party in England, headed by Count Zenardi Landi, has been reported eagerly completing its plans to reach the spot before its American rivals sight the telltale buoy marking the spot where the



HUGE pontoon cylinders pulled down to a sunken vessel and attached to her sides by a caterpillar tractor on the ocean bed, are the nuclei of the system for raising sunken ships devised by Jesse W. Reno, inventor of the moving stairway. With steel claws fastened in holes bored by divers in the ship's sides, the cylinders slowly lift the hull, as compressed air displaces the water within them.

Lusitania was submarined off Kinsale Head in southern Ireland.

Whether or not either of these expeditions meets success this year, it seems certain that the publicity accompanying their enterprise will give new impetus to the salvaging of hundreds of vessels. Some 1800 torpedoed ships lie on the bottom about

the British Isles alone, holding, it is said, many millions of treasure.

In the meantime, experts in the law of the seas are attempting to unravel the twisted question of ownership of these valuable ships. Are they legitimate objects for freebooters? Or is there a higher law of the seas, brought into being by the ravages of submarines, that holds inviolable the original ownership of war-wrecked hulks?

"Sunken Treasure"

The lure of sunken treasure has always caught popular imagination—to such an extent that many hundreds of thousands of dollars have been invested in salvaging enterprises that have never paid dividends. On the other hand, the novel methods recently adopted in getting at the cargo of the *Laurentic*, torpedoed off the coast of Ireland in January, 1917, make it seem possible that the vast wealth supposed to be lying at the bottom of the Atlantic may yet, in large part, be retrieved.

In all classes of salvage, the diver has been the all important factor. Even with modern equipment and knowledge of the art of deep sea diving, divers have found it impossible to perform much manual labor at depths greater than 100 feet. Divers have succeeded in de-

scending as deep as 300 feet, as in the case of the United States submarine F4, sunk in Honolulu Harbor in March, 1916, but this feat was accomplished under favorable conditions and the duration of the descent was limited to a short interval. In this instance the air was fed to the diver from tanks charged at high pressure and with the

air pressure varied by an ingenious reducing valve as the water pressure changed.

Some conception of the great pressure at which divers must work can be had from the fact that at a depth of 100 feet the pressure is 44.4 pounds to the square inch, or three times ordinary atmospheric pressure. At a depth of 350 feet the pressure increases to 155.4 pounds or 10 times normal air pressure.

It is evident, therefore, that salvage work at great depths requires a resistant armor to protect the diver. The leader of the American expedition to the *Lusitania* is staking his success on a strange diving suit with which he claims to have worked at depths up to 351 feet, the world's diving record. The Leavitt suit is made throughout of manganese bronze, a composition that is proof against the corroding effect of salt water. Freedom of action is supplied by ball bearings at the joints.

Details of Armor

The flexible sections of the suit consist of interlocked copper tubing wrapped and lined with sheet rubber. On the back of the suit a specially constructed air chamber supplies the diver with air at the proper pressure for four hours. The helmet has four one-half-inch non-shatterable glass windows, and is also equipped with a telephone, which enables the diver to keep in constant communication with those on board the work ship.

The Leavitt plan of operation is to lower the diver to the deck of the sunken liner to locate the positions of the purser's room and the strong rooms. Charges of nitroglycerin will then be placed at the tops of these points and these charges electrically set off after the divers have ascended. The divers will again be lowered to the wreck and will enter the purser's room and the strong rooms. Chains hooked to the treasure chests will be raised by boom winches and tackle on board the steamer *Blakeley*, which is to carry the expedition and act as working headquarters.

Vast Wealth on Ocean Floor

Perhaps the *Lusitania's* treasure has been overestimated. Perhaps, sinking first, her prow hit the bottom with shattering impact and her boilers exploded, leaving—as some experts insist—only scattered debris for the divers to find. But if the Leavitt suit can be successfully employed at working depths of more than 350 feet as the inventor claims, its use opens up other tempting possibilities.

It has been estimated by one salvage company that almost 8000 vessels, of all kinds and descriptions, valued at more than \$7,000,000,000, were sunk during the world war, and many thousands of other vessels have been sunk in the seven seas during the past 100 years. Most of these vessels rest at depths of less than 350 feet. Many of these had cargoes worth millions. Among the victims of the submarines are such well known liners as the *Laurentic*, *Oceanic*, *Cymric*, *California*, *Arabic*, *City*

of *Memphis*, *Minnehaha*, *Laconia* and *Kansas*.

But not all the ships now luring treasure hunters were sunk during the late war. The 25 richly laden ships of the Spanish Armada, sunk off the Atlantic coast of Ireland in 1588, are still considered fair prey. The British frigate *La Lutine*, sunk off the coast of Holland in 1799, is said to

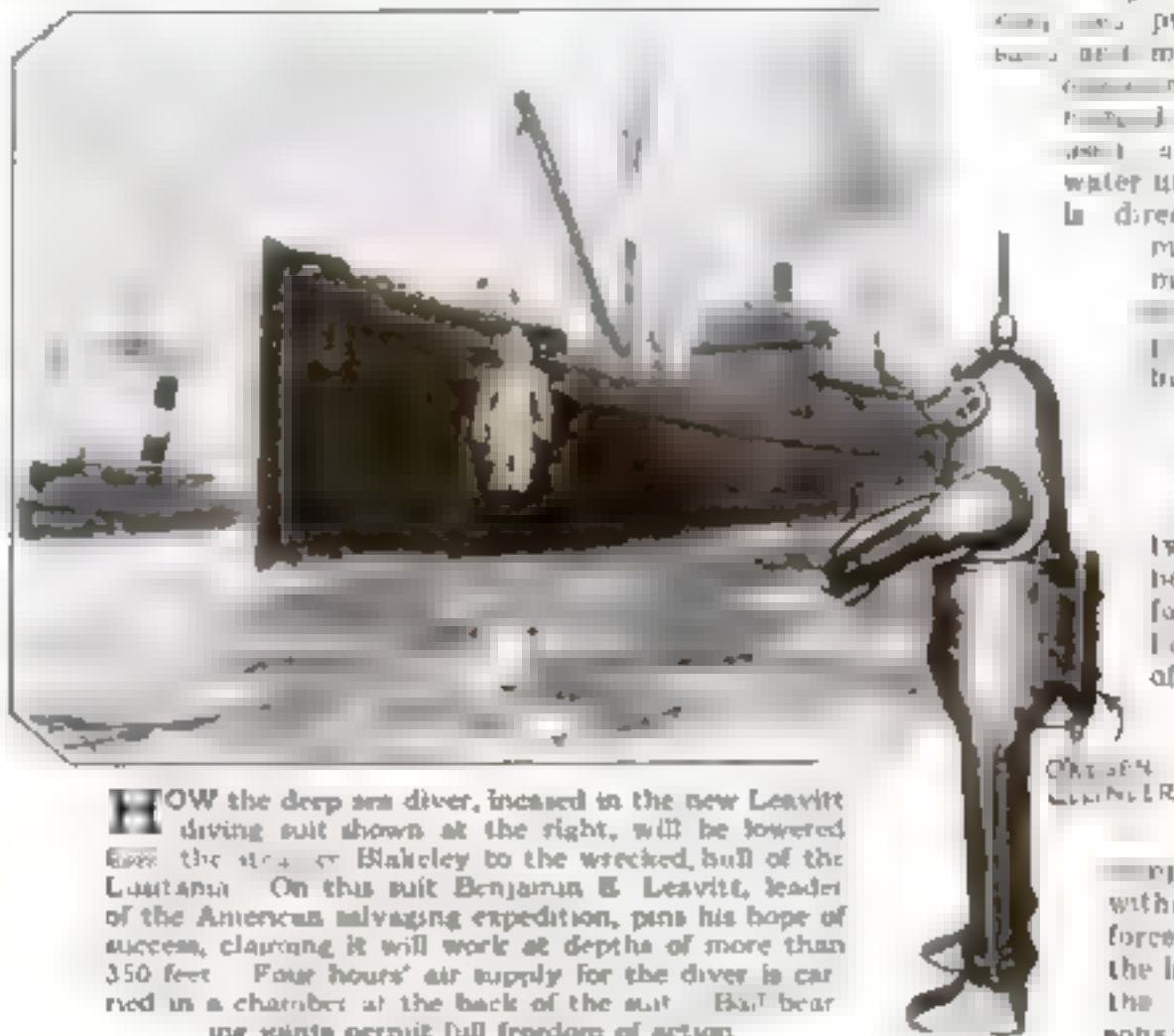
rents, sudden gales, and deep water, they have already recovered between four and eight million dollars' worth of the gold. Efforts are now being made to recover the remainder.

On this job, mechanical instead of hand pumps are being employed to furnish air to the divers. Naked acetylene flame torches (instead of hand tools) are used to cut away obstructions and pumps clear away sand and mud. If the diver complains that these submerged pumps cannot be used, a hose pipe with water under high pressure is directed against the mud and sand in much the same fashion as a fireman plays a hose on a burning building.

Two Methods

In shallow water two methods have been used heretofore in salvaging ships. First, that of pontoons attached to the plates to exert the required buoyancy; second, the use of compressed air, with or without caissons, to force the water out of the hull or from within the surrounding caissons while making temporary repairs.

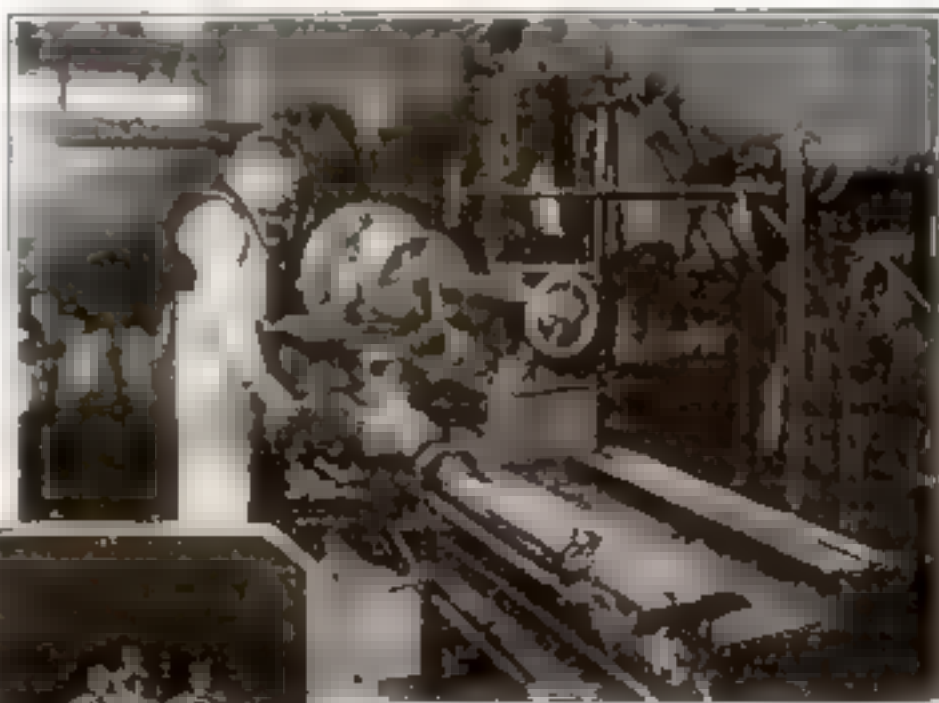
A combination of both of these methods was used to salvage the 20,000-ton dreadnaught *Leonardo da Vinci*, which sank and turned turtle in 86 feet of water in the Mare Piccolo as a result of a magazine explosion. The liner *Royal George* was pulled off the rocks in the St. Lawrence River by the novel use of compressed air. That portion of the ship in which the hull rents were located was made air-tight to the lowest deck above and then compressed air was forced into the compartment thus



HOW the deep sea diver, incased in the new Leavitt diving suit shown at the right, will be lowered from the steamer *Blakeley* to the wrecked hull of the *Lusitania*. On this suit Benjamin E. Leavitt, leader of the American salvaging expedition, pins his hope of success, claiming it will work at depths of more than 350 feet. Four hours' air supply for the diver is carried in a chamber at the back of the suit. Ball bearing joints permit full freedom of action.

still hold a treasure worth more than \$2,000,000. In 1782, more than \$120,000,000 in gold and silver bars are believed to have been sunk with the Spanish argosy defeated by Admiral Sir George Roke, in Vigo Bay.

Success in salvaging can be attained only after beating Nature and the elements in their dogged attempts to aid the sea to keep what it has collected. But while most expeditions have been failures, there are many instances of the recovery of precious cargoes, although the foundered ships have lain at less depth than the *Lusitania*. The British Admiralty's successful work on the *Laurentic*, torpedoed while carrying \$14,000,000 in gold in gobs for the British government is a notable example. Working again at the odds of swift cur-



The lathe on which the manganese bronze parts of the Leavitt diving suit were fashioned is shown above.



At the left are five of the suits to be used in the *Lusitania* expedition, ready for assembly.

formed in much the same manner as an air lock used in under water tunnel construction. This air forced the mud and water out of that portion of the hull so that men could work inside of it to place temporary wood patches over the holes until steel patches could be measured, made and attached to the outside of the hull by divers.

Among the many improved salvaging devices invented in recent months but not yet tested practically is a huge concrete monolith float like the famous "mystery towers" of the British Admiralty. The inventor of this device would raise the Lusitania by passing 800 cables under her between stem and stern and then drawing these cables taut by machinery on the float.

Another inventor, Jesse W. Reno, originator of the moving stairway, has recently invented a unique system of pontoons for raising a sunken ship. His scheme makes use of tall steel cylinders closed at the upper ends and open at the lower ends. These cylinders are first hauled down under water and attached to the ship by means of claws that fit into holes bored in the ship's sides; then they are filled with compressed air. The increased buoyancy raises the vessel to the surface, where it is taken in tow and beached. Steps in the procedure are these.

A Submarine Tractor

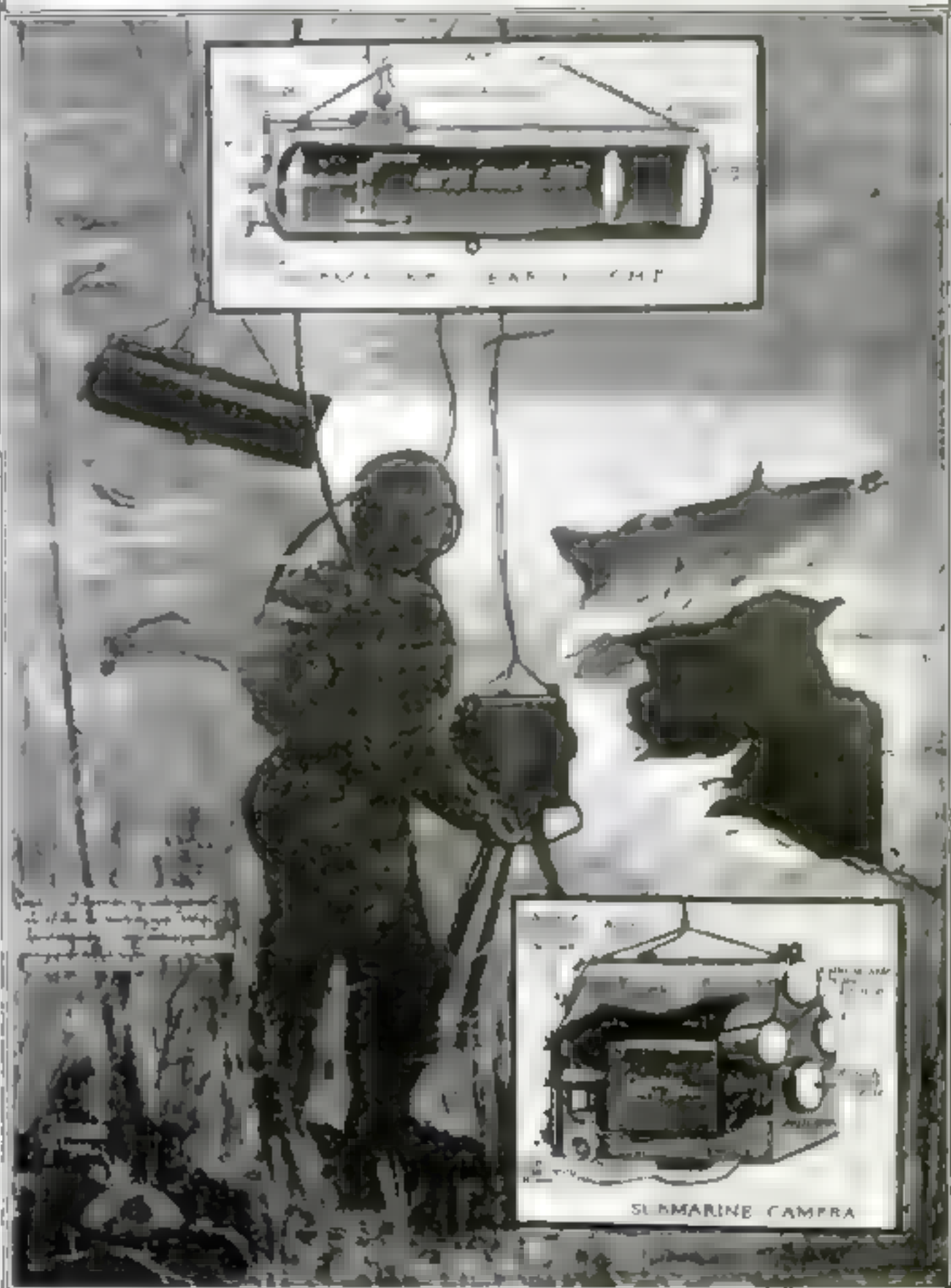
After the ship has been located by buoys, a caterpillar tractor heavily weighted and carrying two divers is lowered to the ocean bed. The tractor travels by its own power to the ship's sides, where the divers bore a series of double five-inch holes around the vessel. At the surface of the water each pontoon in turn is then placed in position above the tractor and attached by a cable to a windlass on the tractor. When all is ready, the windlass hauls in the cable and pulls the cylinder downward. As soon as the cylinder is in position, its two-pronged claws suspended from chains are inserted in the double holes by means of an iron hand that slides out from the tractor.

The final process of lifting the heavy water-filled bulk is accomplished by introducing an air hose under the lower open end of the pontoons and allowing compressed air to bubble up into the cylinders, gradually expelling the water and increasing the lifting power until the ship rises to the surface.

Two remarkably ingenious instruments, developed during the war to combat submarines, that are now proving of tremendous value in aiding the work of treasure hunting divers, are the under water searchlight and camera.

The searchlight is inclosed within a strong aluminum casing fitted with a stout outer lens. To prevent the heavy water pressure at great depths from breaking the glass or possibly forcing its way into the casing, a one-quarter-inch flexible pipe is coupled to the casing and led up to above water level, where it is connected with an air compressor. The searchlight reflector is parabolic and the powerful burner is adjustable for focusing by means of a small

New Submarine Camera to Snap Weird Photographs on Ocean Bottom



ACTUAL photographs of the strange scenes of wreckage and deep-sea life, hitherto familiar only to divers, may be made available to all by the use of a newly invented submarine camera and searchlight. This searchlight, now being developed in England, is lowered into the water by chains and permits divers in the sea bed. It is filled with compressed air, to prevent breaking of the lenses. Its powerful beams supplement three 300-candlepower searchlights attached to the camera, and pierce the darkness of the ocean. Their intensified rays act like powerful spotlights, and clear photographs, even at great depths.

wheel outside the casing. The front lens is eight inches in diameter. The apparatus is weighted and lowered into the water by chains or cables. It can be guyed to weights or anchors on the sea floor and tilted to the required angle, or mounted on a special form of tripod.

The camera carries its own apparatus for lighting up objects to be photographed. It is inclosed in a cast steel outer case in which are fitted four lenses. Three of these are five inches in diameter and behind each is a 300-candlepower light. The fourth lens is in front of the camera. In-

side the case is a 12 by 14 inch box camera, which moves on rails for the purpose of focusing, and is operated by a controlling hand wheel. Another hand wheel is provided for changing the plates or films. A window or sight equipped with a ground glass screen, enables the diver to ascertain when the focus is correct.

The camera and searchlight would both prove invaluable, it is expected, in exploring the Lusitania wreck and locating the exact positions of the purser's room and the strong rooms where the bulk of the treasure is believed to rest.

Planes Turn Handsprings to Prove Their Strength



Starting the Somersault

The "somersault" test shows the beginning to the "loop-the-loop" used when the

TRIPPING an airplane so that it stops abruptly and stands on its heel is a spectacular ground test recently performed by Italian pilots to demonstrate to army authorities the strength of the Gabardini machines. In the tests pictured above, two pilots ran their machines along the ground, then, suddenly opening up their engines, pushed their elevator controls forward so that the slip stream from the propeller lifted the tails high in the air. The machine shown at the left turned a complete somersault.

Another Daring Exploit

Landing on one wheel, as shown at the right, was accomplished recently by Pilot L. C. Wenberg, at Dayton, Ohio. In "taking off," the left wheel snapped away. To make a landing, Wenberg banked his left wing as the right wheel touched ground, and held the plane at an angle. The machine veered along on the right wheel for a short distance, then tipped on its nose.



Protractor and rule are pivoted on the suction cup shown in inset.

Vacuum Holds Protractor to the Blackboard

A BLACKBOARD instrument consisting of a protractor and rule supported by a suction cup around which it revolves has recently been perfected.

The suction cup is pressed hard against the wall or blackboard surface forming a partial vacuum that holds the device for 15 minutes. The protractor and its rule are pivoted on the cup and can be rotated completely around it. For convenience in classroom work the rule is perforated at frequent intervals. Chalk may be placed in any of the holes to produce circles as the instrument is revolved.

TREES on which birds warbled their morning songs were turned into newspapers by noon in a recent test in the Hara district, Germany. The entire process took three hours and twenty-five minutes.

Electric Motor Drives High Speed Hacksaw

DRIVEN by a small electric motor that can be plugged into any shop lighting circuit, a high speed bench type hacksaw for tool steels and soft metals has been marketed by a New York manufacturer.

The rotary motion of the motor is translated into reciprocating motion for the saw by means of gears and crank. During the forward stroke of the eight-inch saw the teeth are saved from wear by a mechanism that lifts the saw from the work.

A sliding weight on the top arm of the saw varies the rate of cutting at the operator's wish. A small lever on the base engages the saw and when the blade finishes the work and stops the machine.



The motor's rotary motion is translated into reciprocal motion for the saw.



Tiny Tabulator Records Blood Corpuscles

COUNTING blood corpuscles for the purpose of diagnosis has been facilitated by the recent invention of a tabulator—a small adding machine with keys for each kind of corpuscle. This machine, designed by Dr. C. Penafior, of Manila, P. I., records the total for each kind of corpuscles, ringing a bell whenever the count reaches 100 or a multiple of 100.

The little adder is only two inches high and six inches square.

Blood is not a homogeneous liquid, but is composed of plasma and corpuscles, of which there are several kinds: the red corpuscles, which constitute about 50 per cent of the entire mass of blood, and five varieties of white corpuscles. One cubic millimeter of blood contains an average of 5,000,000 red corpuscles and about 10,000 white corpuscles.

As the relative percentage of the different corpuscles varies in accordance with certain changes in the organism, for an accurate diagnosis it is often necessary to count the different corpuscles contained in a given minute quantity of blood.

Sound Waves Snap Bullet Photographs

Speeding Projectile's Whine Sets Off Flashlight, Taking Most Amazing Pictures of the Kind Ever Printed

MAKING photographs of bullets as they fly through the air at speeds as high as 5000 feet a second, the United States Bureau of Standards, by remarkable new flashlight methods, has succeeded in actually snapping pictures of the bullets' whine!

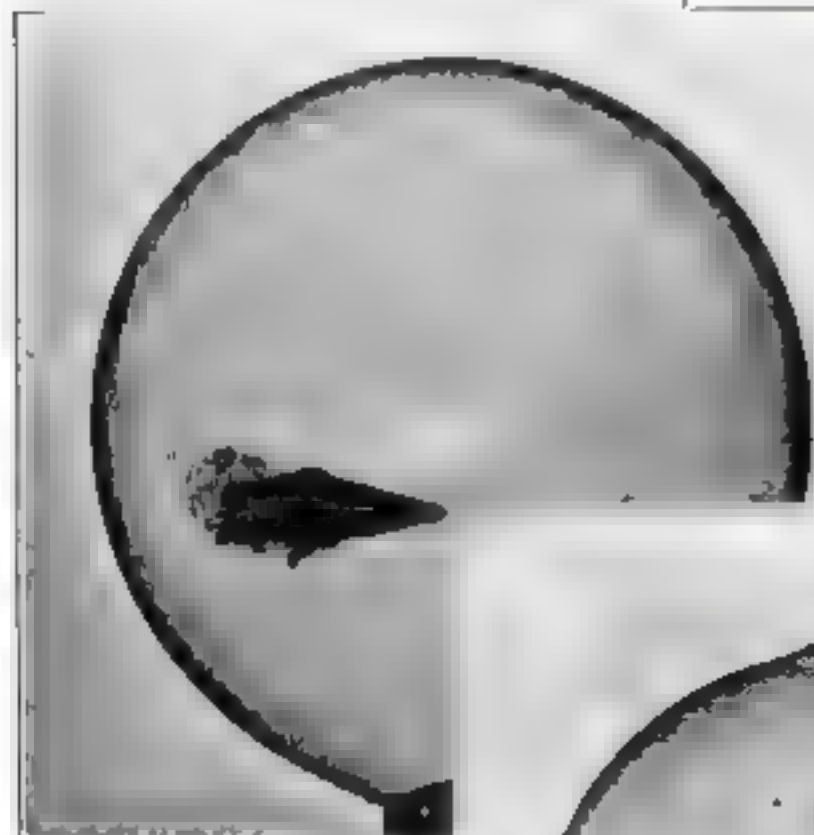
In a split interval, while two sparks flash brilliantly across gaps in a dark room, the camera records not only the actions and character of a bullet as it cuts the air—whether it holds steady or tumbles and gyrates in its course—but also photographs the sound waves set in motion by the nose of the projectile. Strangely enough, these very sound waves "pull the trigger" that sets the photographing apparatus in motion. The resulting pictures of the waves make possible accurate measurement of the bullets' velocity.

What Happens in Split Second

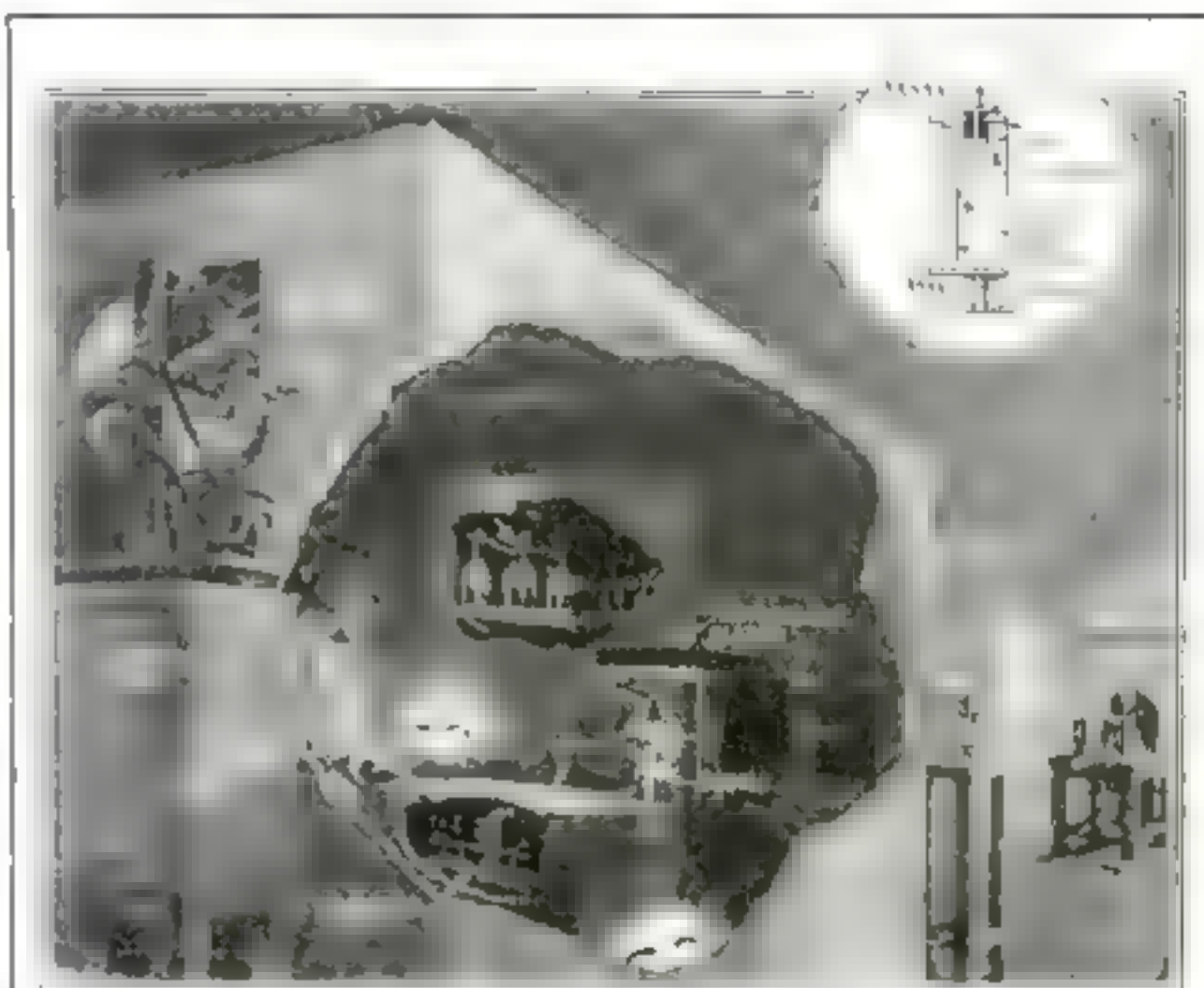
Less than one fiftieth of a second elapses between the movement of the trigger and the passage of the bullet in front of the sensitized photographic plate, yet in that instant the bullet is impelled from the rifle barrel, passes close to a delicate diaphragm that controls the photographing apparatus, shoots through the recording chamber where the plates are exposed, and finally

Photo of a Bullet Passing through Soap Bubble

Photograph by courtesy of the Franklin Institute



These remarkable photographs of a 30-caliber pointed bullet passing through a soap bubble reveal the amazing speed of the new photographic apparatus. Above, the bullet is entering the bubble, and at the right it is passing out. Note that the camera has caught the punctured bubble before its collapse.



How These Startling Pictures Were Taken

Leaving the rifle at the extreme right, the bullet passes close to an interrupter (explained in the diagram), where the projectile's sound waves, striking a diaphragm, trip a magnetic switch that sets off two sparks in the apparatus chamber. These sparks photograph the bullet on two sensitized plates just before its flight ends in a sand box.

terminates its flight in a sand box.

So rapid is the process that a bullet, after passing completely through the thin walls of a soap bubble, is

photographed before the bubble collapses.

The new method has been evolved by the Bureau of Standards from the suggestion of Dr. D. C. Miller, of the Case School of Applied Science.

In carrying out the experiment, the rifle is placed in a test block 60 or 70 feet from the recording chamber. A short distance in front of the rifle a device called an "interrupter" is placed. The interrupter consists of a thin vertical diaphragm against the back of which a light hammer rests. Any action of the diaphragm moves the hammer and breaks the contact between it and its support. When adjusted for the experiment, the diaphragm is set close to the trajectory of the bullet. The impact of the sound waves from the speeding bullet, striking the diaphragm, kicks the hammer away from its support and breaks a circuit of which it is a part, setting off sparks that supply the actinic light for the photograph.

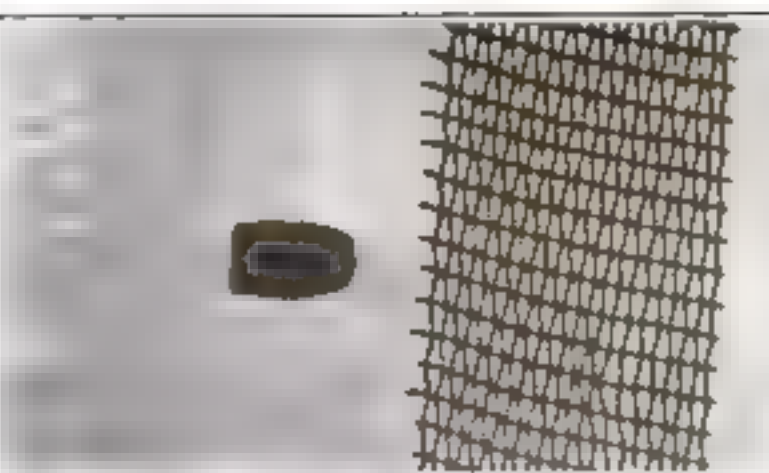
These sparks are generated by a motor-driven static machine and stored in a battery of Leyden jars.

Bullet Leaves the Bubble Before It Collapses

A potential regulator automatically cuts out the static machine and short circuits its terminals as the voltage reaches a certain point. When the regulator disconnects the static machine, it automatically connects the Leyden jars with two spark gaps, one for a vertical photographic plate and the other for a horizontal plate.

But in series with this circuit is another gap with its spheres set at such a wide distance that the spark potential of the jars cannot jump it. When the bullet passes near the interrupter and causes the hammer to break its cir-

Photo of Sound Waves



At right—A bullet above screen. No sound wave after it. Its speed is less than that of sound.

At right—A bullet after piercing a board. Each fragment has a blunt sound wave.

At left—Modified Spitzer bullet, speeding 1,000 feet a second, and its sharp sound waves.



IF NOTHING is known of the speed of a bullet to be investigated, a wire screen is first placed in the line of fire in front of the photographic plate. If the image of the screen is punctured when the plate is developed, it proves that the bullet passed the plate before the spark occurred. The sparking apparatus is adjusted accordingly.

cuit, a magnet is actuated, dropping a small wire in the long gap. This shortens the arcing distance and the sparks jump the series gap and likewise the vertical and horizontal gaps. If computations have been accurately made, these sparks occur at the exact instant the bullet passes before the plates. As a result, two silhouetted images of the projectile are impressed on the plates—a plan and an elevation. These images serve as records of all motions of the bullet. The advantage of two images lies in the facilities they provide for further investigation of the trajectory of the bullet.

Whenever the bullet has a speed greater

than that of sound, an image of the bow wave is projected on the plate. This is because the nose of the bullet, as it cleaves its path through the air, causes a high compression immediately at its front, and this compression radiates in a conical wave. The illumination of the spark, passing through the denser air, is refracted, causing a distinct image of the sound wave on the sensitive plate. But if the bullet has a velocity less than 1,080 feet a second, as in the case of the ordinary .22-caliber cartridge, this wave will not be in evidence. Conditions are exactly similar to those of a boat traveling with the current. If its speed is greater

than that of the stream, a bow wave of water will be thrown up, the angle of the receding wave becoming sharper as the vessel increases its speed. The faster the bullet, the sharper will appear the accompanying sound waves.

By measuring the angle of the bow wave on the developed plate and substituting proper figures representing the known distances between spark, bullet, and plate, and the length of the trajectory between rifle and plate, the Bureau of Standards has developed a formula for using the method as an accurate measurement of the velocity of projectiles.

Armstrong Super-Regenerative Circuit Heralds New Radio Era

A REVOLUTIONARY improvement in the design of radio receiving circuits, giving perfect amplification of 100,000 times or even more, limited only by the mechanical construction of the vacuum tube, now stands to the credit of Maj. E. H. Armstrong, already famous through his invention of the "feed back" circuit. Major Armstrong recently revealed to members of the Institute of Radio Engineers in New York, the details of his amazingly simple yet epochal invention, the "super-regenerative circuit."

THE keenest imagination can hardly forecast the effects of this new hook up on the radio industry in general, while the satisfaction to be obtained by the public, henceforward, from radio broadcasts is apparently to be enormously enhanced, thanks to Armstrong's genius.

For ordinary distances in radio communication, such as are encountered in the reception of broadcasted concerts, entertainments, and news, Armstrong's new circuit eliminates entirely the outside aerial. With small loops, three or four feet in diam-

READ WHAT JACK BINNS SAYS on page 76 about the young wizard of wireless, E. H. Armstrong, and his contributions to radio history.

eter, it brings in stations many hundred miles distant, amplifying the signals for a loud speaking device. The quality of communication will be improved, due to the elimination of static and atmospheric strays, which have but slight disturbing effect on low aerials of small dimensions.

With an outside aerial and this super-regenerative apparatus, there would seem to be no limit to the long-distance reception of continuous wave or spark messages in code. Signals that now are unheard, will be picked up and strengthened to deafening intensity.

Research into unknown worlds will be hastened. Investigation of the communicative vibrations of insects will be simplified. Realms that hitherto have been considered closed to the scientists will be opened wide by the tremendous amplification now available.

And yet, with all these wonders, the su-

per-regenerative circuit is not intricate. Three hook ups have been devised by Major Armstrong to attain the results he has long sought. He describes two of these as requiring three tubes, while the third circuit, which, fortunately for the amateur, happens to be best suited for telephony, requires but two tubes. In this circuit less apparatus is needed than in the two-stage audio frequency amplifier.

IN SIMPLE terms, the new super-regenerative theory is based on the use of vacuum tubes, or tubes to decrease the resistance of the regenerative circuit to less than zero, so that the circuit in reality possesses what electrical engineers call "negative resistance." But as this condition in an ordinary circuit causes the tube to function badly, a method had to be discovered by which the average resistance could be made negative, and at the same time maintain the tube in a stable condition. This was the problem successfully solved by Major Armstrong. It will be described with all possible detail by Jack Binns in the next issue of POPULAR SCIENCE MONTHLY.

Toboggan-Hydroplane Is New Seaside Thriller

THRILLS a-plenty—new, unusual combinations of thrills that add the exhilaration of the snow paved toboggan chute to the spray whipped run of a hydroplane—are provided in a novel water toboggan invented by F. M. Catron and J. W. Sherman, of Tampa, Fla.

The new sport consists in "shooting the chutes" on a small flat bottomed car from the top of a 45-foot tower down a steep incline 118 feet long to the water level and then skimming over the surface of the water for 150 feet or more. The car is said to travel over 60 miles an hour as it leaves the chute.

Sled Runs in Grooves

The toboggan on which the rider drops from sky to sea is a flat sled turned up slightly at the forward end and equipped with foot rests and braces. Guide runners on the under side slide in grooves sunk in the chute. To lessen the friction of the runners, as the loaded car travels its breath-taking course down the runway, a constant supply of water is pumped into the grooves at the top and allowed to trickle down their entire length. Rear end collisions are prevented by a system of signals and locks that regulates the movement of the toboggan sleds.

After thrill lovers pay the entrance fee, a sled is carried up a stairway extending alongside the chute to the top of the slide. There the operator inserts a hook in an eyelet in the rear of the sled and the occupants climb aboard, bracing them-

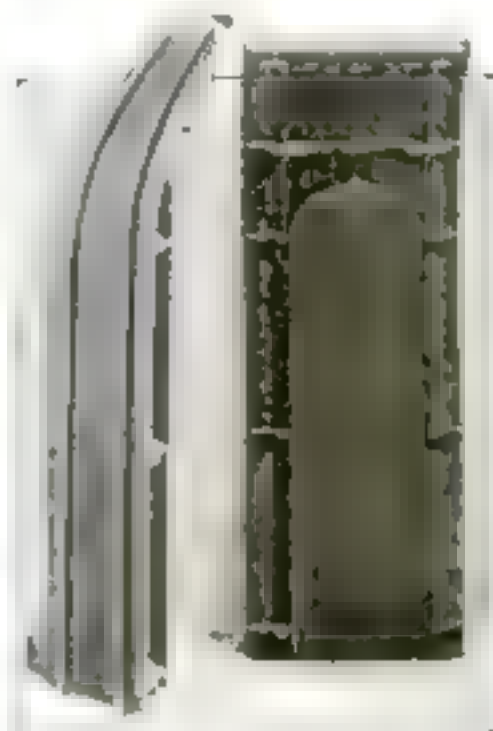


Shooting down a steep incline from the top of a 45-foot tower, the flat bottomed toboggan sled shown at the right skims with its passengers over the water for 150 feet.

selves securely by holding to cross pieces. At a signal from an observer at the lower end, signifying a clear track, the operator at the top releases the loaded sled by pulling

a lever. With a tremendous swoop the sled increases its speed almost as rapidly as if it were falling freely through the air. At the bottom, the sled travels as fast as a racing automobile.

If allowed to take its own course, the toboggan glides in a straight line for 150 feet; but the occupant may direct it to any part of the beach by dragging his hands in the water on the side. Considerable skill is required to guide the sled and prevent it from capsizing.



A device that automatically compensates for the rise and fall of the tides readily adapts the water toboggan for use at seashore resorts.

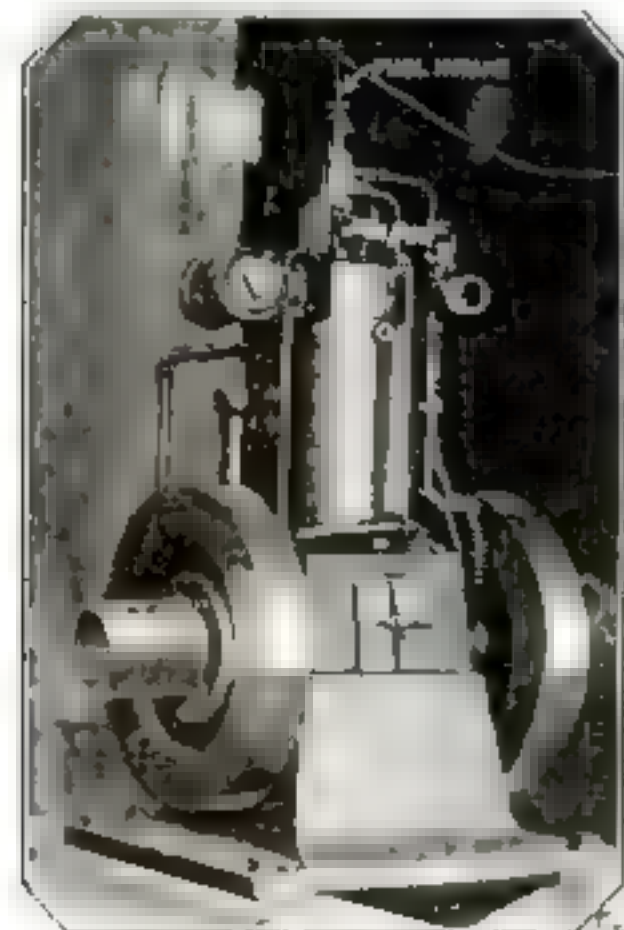
Will Mystery Engine Run 300 Miles on a Gallon of Oil?

THREE hundred miles on a gallon of oil—10 times the mileage possible for the usual present-day motor!

Such is the astounding record claimed for

a crude-oil engine developed by Harry H. Elmer, of Syracuse, N. Y., for use in automobiles, airplanes, ships, and lighting systems. In experiments, the engine has generated sufficient power to run a battery of 18 incandescent lamps 18 consecutive hours on 1 1/2 parts of oil, costing less than a cent.

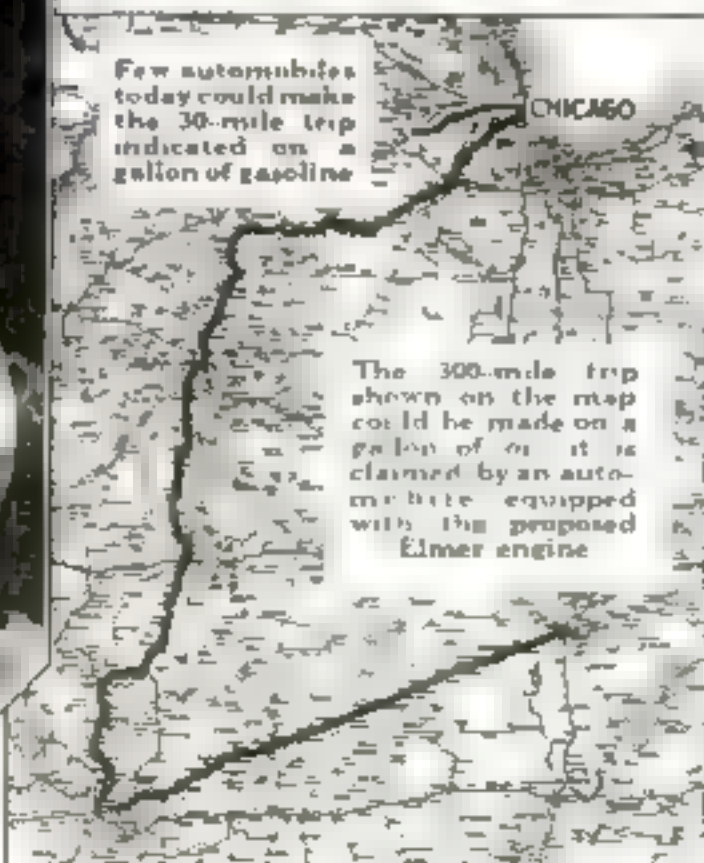
Because this mechanical marvel does not require a cooling system, government officials, it is reported, are studying the possibility of its use in dirigibles.



Only 64 parts, including screws and bolts, are said to be included in the new Elmer oil engine shown above.

Few automobiles today could make the 30-mile trip indicated on a gallon of gasoline.

The 300-mile trip shown on the map could be made on a gallon of oil, it is claimed, by an automobile equipped with the proposed Elmer engine.



Among more than 300 radically new features claimed for the engine, the most important are these:

It contains only 64 parts and has only three adjustments.

It has no spark, carburetor, wiring, nor any sort of ignition.

The cylinder has a bore of 3 1/4 inches and a six-inch stroke, yet the engine, it is said, has developed 200 per cent more power than internal combustion engines of the same size, and will pick up almost instantaneously from 100 to 2800 revolutions a minute.

How the Motor Operates

The new engine is described as a four-cycle motor, the cycles being suction, compression, expansion, and exhaust. The crude oil is led through needle valves into mechanism, where it mixes with air and then, through another valve of the same kind, is drawn into the motor head, where it is compressed by the upward stroke of the piston. On compression the oil is "cracked" by chemical process and the expansion of gases takes place. As the piston is forced down, the exhaust port is opened, and the incoming charge forces out the expanded gases.

There is no combustion in the cylinder, though hydrocarbon gas, escaping the exhaust, explodes on uniting with atmosphere.

The engine has been operated with equal success on mineral, animal, and vegetable oils.

Can Man Steal "Cold Light" from Nature?

The Truth About Light Producing Fireflies and Fish, Now the Object of Scientific Research, Told in a Nutshell

Photographs by courtesy of Dr. Ulric Dahlgren, Princeton University

TINY shrimplike sea creatures living at the bottom of the ocean near Japan may lead scientists to an early discovery of how to produce heatless "light" in commercial quantities — an achievement that has been sought by man for centuries.

Searchers in science have known for years that the source of phosphorescence in certain species of insects, fungi, and fish is a substance known as luciferin. But the extreme difficulty in separating enough of the luciferin for experimental purposes has prevented any worthwhile revelations. Lately, however, Professor E. Newton Harvey, of Princeton University, has discovered a means of concentrating the luciferin from a multitude of tiny sea crustaceans called "Cypridina," and of producing from it a light brilliant enough to read by.

Professor Harvey's discovery involves a method of drying the small creatures as soon as they are obtained and of grinding them into a fine powder for later use in his experiments. They must be dried immediately and at a rapid rate as soon as they are removed from the water, otherwise the luciferin unites with the oxygen of the air and water and is rendered useless.

Luciferin itself does not give off light, but when combined with a second substance called "luciferase," the combination with oxygen causes the phosphorescence. To demonstrate the light giving properties of luciferin, a quantity of the yellowish powder is dropped into a flask with water. When the contents are violently shaken, a blue greenish light appears and spreads over the inside of the flask. From a small flask enough light is generated to illuminate the page of a news-



Is heatless light in animal organisms primarily for protection against enemies? This theory seems to be borne out by observation of the parchment worm that makes its home in "parchment" lined burrows in the ocean mud. Ordinarily the worm is not luminous, but when attacked by its enemy, the eel, it glows brilliantly, apparently to frighten its assailant. Other worms in the vicinity also begin to glow.

WHILE biologists are learning how to produce heatless light from creatures of the air, land, and sea, astronomers, studying the vast expanses of the heavens, are discovering in this same "cold light" a possible solution of one of the greatest mysteries of the universe—the strange luminosity of vast, far-flung mists that form the primitive gaseous nebulae.

Scientists find it hard to believe that these thin gases, exposed to the terrific cold of space, can derive their light from heat. Whence, then, their brightness?

Read, in the next issue of POPULAR SCIENCE MONTHLY, a gripping romance of the night skies, explaining new theories of these vast nebulae.

paper to permit one to read in comfort.

Unlike most instances of combustion, the uniting of luciferin and oxygen under proper conditions produces very little heat. It is estimated that more than 99 per cent

of the energy released is in the form of light, with less than one per cent of heat. Contrast this with the ordinary incandescent lamp which gives off 96 per cent of its energy in the form of useless, bothersome heat and only four per cent as light.

The color of the light from luciferin is the explanation for the absence of heat. Practically all the illumination consists of green and blue rays, which are the cold rays of white light. Heat is the result of red rays, which are noticeably absent in luciferin. A thermometer inserted in a glowing flask of luciferin light for several minutes shows an increase of less than one thousandth of one degree of heat.

Cold light, more commonly referred to as phosphorescence, is present in many species of salt water fish and marine worms. The method of producing the light varies with the species. In some cases it is caused by secretions of minute cells from the body surface of the animal. In practically every instance it is necessary for the secretions with their content of luciferin to come in contact with some rich substance such as slime or mucus, which supplies the luciferase. In the slime the

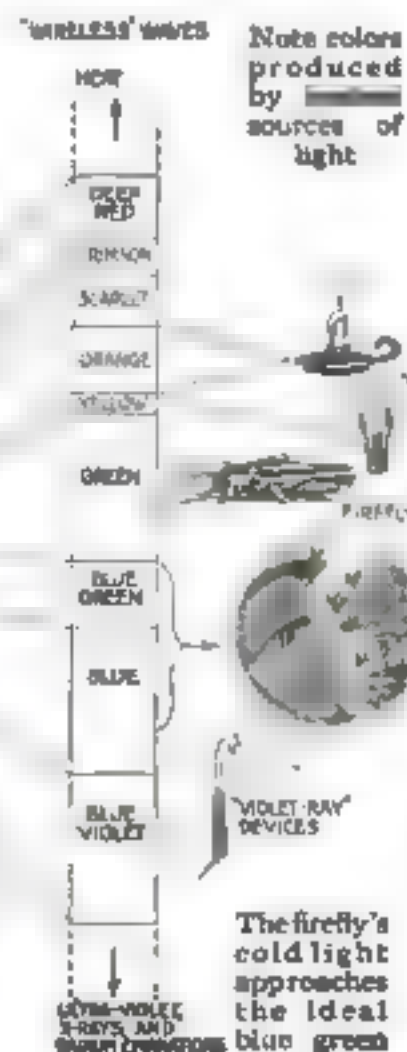


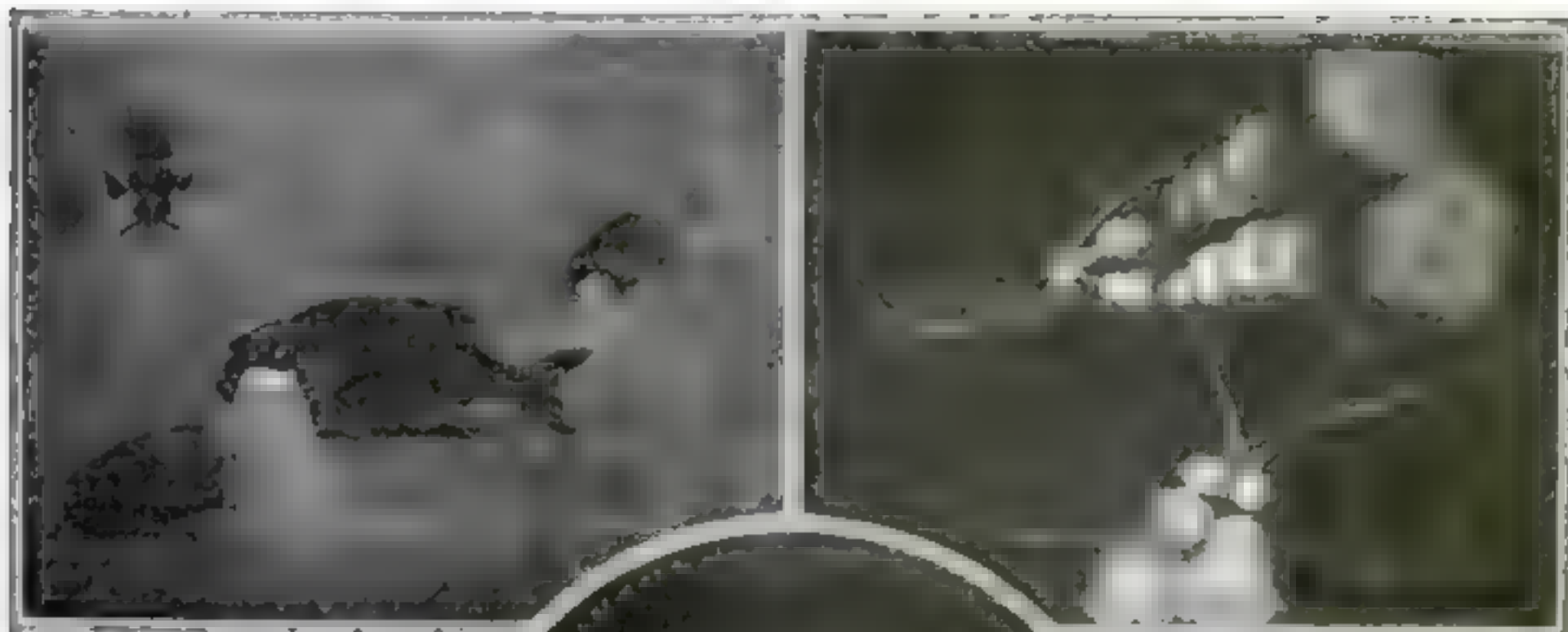
AT ONE end of the great series of wave lengths now recognized by science are the very short radium emanations and X rays. At the other end are the great radio waves, often a mile or more from crest to crest. Toward the center is the little band of visible light rays, flanked on one side by ultra-violet rays and on the other by the infra red (heat) waves.

Scientists are puzzled to know what mysterious power—like thought transference, perhaps—may lie in the bands of wave lengths that are marked "unexplored" on the above chart.



When passed through a prism, rays of white light are separated into distinct colors. Nature's prevailing colors are blue-green and blue.





A Dimmer System

This species of lantern fish, called *Photichthys*, has a dimmer system in town. The light is produced in an inside chamber and burns continuously. When the fish wishes to shut off the light, he causes a black pigmented curtain to slide down over the light and opening like an eyelid. The light organ preserves its luminousness even when removed and is used by fishermen of the islands of Banda about 800 miles southeast of the Philippines, as bait for night fishing.



"Smoke Rings" of Light

The *Arctostea*, a deep sea glow worm, is a creature that glows for a distance of a half mile or so. It is created by the reaction of an enzyme in the water and a substance in the body of the worm. The glow is produced by the reaction of the enzyme and the substance, which is called luciferin. The glow is produced by the reaction of the enzyme and the substance, which is called luciferin. The glow is produced by the reaction of the enzyme and the substance, which is called luciferin.

A Deep Sea Struggle

When a fish desperado approaches a polychaete worm, the polychaete causes a brilliant luminescence to appear over the body of the worm, evidently in an attempt to frighten away the intruder. In the illustration below, a crab has snatched a worm in two. The second part is hardly suited in an effort to hold the attention of the assassin, while the first part sneaks away in darkness to safety and new growth.

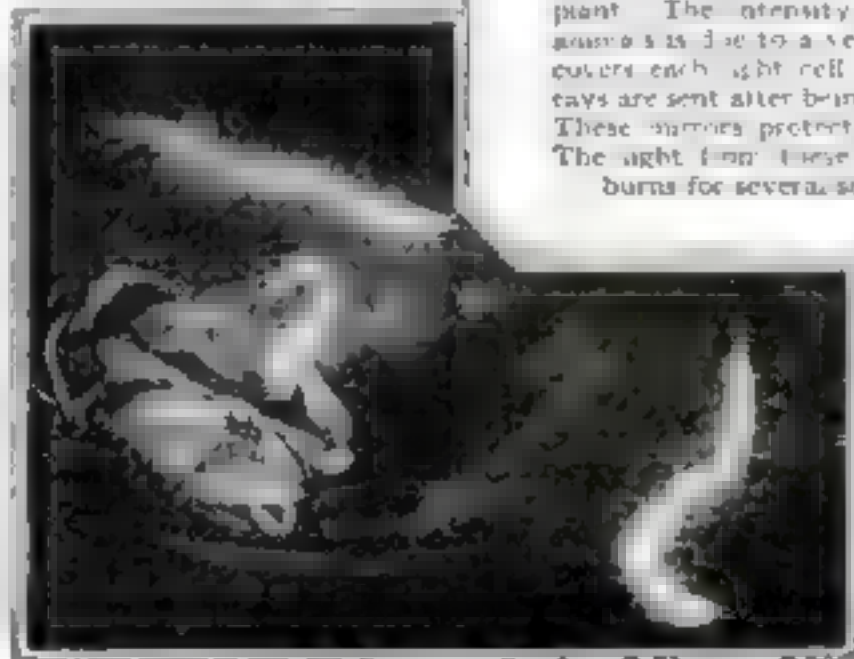
Swimming Lighting Plants

Ten small light sources scattered over a tiny body turn the deep sea shrimp into a swimming lighting plant. The intensity of the light from these sea animals is due to a very complex lens system that covers each light cell and through which rays are sent after being reflected by many reflectors. These barriers protect the body tissues from light. The light from these shrimps does not burn but burns for several seconds with a steady glow.

Sharks that Gleam

Some forces of black sharks living in the deepest part of the sea are startled with thousands of tiny lights. These lights are produced by the reaction of an enzyme and a substance in the body of the shark. The glow is produced by the reaction of the enzyme and the substance, which is called luciferin. The glow is produced by the reaction of the enzyme and the substance, which is called luciferin. The glow is produced by the reaction of the enzyme and the substance, which is called luciferin.

far as





Deep-sea shrimp found on the Japan Sea bottom with a glowing light organ. The light organ is a small, white, oval-shaped structure, and the shrimp is shown in a dark, deep-sea environment. The light organ is located on the head of the shrimp, and it is shown in a close-up view.



In the firefly, and most species of luminous organisms, there is no true lens, the light merely shining through the cuticle, which is transparent over the light organ, whereas over the rest of the body it is dark and pigmented. But in the deep sea shrimp, which has light organs scattered over the surface of the body, the cuticle covering the light organ forms a marvelous concavo-convex lens, behind which are the photogenic or heatless-light cells. The lens is made up of three layers of peculiar curvature, and is bluish in color, which suggests that it may serve also as a color filter.

Even fishes in the same family have entirely different methods of lighting. A certain species of shrimp possesses a large number of glands opening by fine ducts into the stream of respiratory water. When the animal is stimulated, the luciferin is ejected into this stream and is thus blown out in front of the organism in clouds of light. These clouds have the appearance of smoke rings blown into the air.

Is Light a Weapon?

Studies of available specimens of fish have failed to reveal the reason for the luminescence. The general impression among scientists is that the light, appearing at its maximum intensity when the organism is agitated, is primarily for protection against enemies. This is borne out by the parchment worm, which makes its home in the ocean mud. Under ordinary conditions the

worm is not luminous, but when attacked by its enemy, the eel, quickly comes to full luminescence, with the evident intention of frightening its antagonist. As soon as the commotion begins, other parchment worms in the vicinity are sympathetically excited and they, as well, illuminate the struggle with their flaming lights.

Most of the foregoing examples of cold light are present in forms of animal life seldom seen by the layman. Fish that live on the ocean bed at great depths have need of these light-giving organs. Other species use the light emission as a protection against their enemies. Scientists searching for the specimens are practically the only persons who come in contact with them.

A remarkable collection of photographs of these strange, little known creatures of land and sea has been made by Professor Ulric Dahlgren, director of biology, Princeton University, and director of the Harpell Laboratory at Bar Harbor, Me., to whom POPULAR SCIENCE MONTHLY is indebted for the photographs illustrating this article.

The Firefly's Light Plant

One example of "cold light" is familiar to us all. The firefly that is seen in meadowlands after dark, flashing its penetrating beam as it flies, has piqued the curiosity of scientists for years. The light cells of this insect are located behind a thin transparent layer of tissue and are backed by other reflector cells containing calcium urate. This chemical picks up the light rays from the generating cells and focuses them back through the transparent skin of the firefly. The air supply on which the burning of the luciferin depends is provided by

(Continued on page 90)

to multiply rapidly until they are numerous enough to give off a visible light. If one of the phosphorescent worms is placed in a pail of sea water and roughly agitated, the secretions will illuminate the water for some minutes.

Certain species of fungi, especially some types of toadstools, give off a brilliant phosphorescence. These toadstools vary in the permanence of their self-lighting system. Some of them secrete the light-giving substance continually during their lives. Others confine this strange phenomenon to a few days or hours. In some of them the lighted surface extends over the entire body,

The luminous jellyfish from the Mediterranean is shown above in both its lighted and unlighted states. When this creature is stimulated, luciferin, secreted in tiny granules in light cells scattered over the surface of the skin, is ejected into the water, and the light appears in slime covering the body.

vided with a black mantle, which it slides over the light cells to cut off the light when not needed. Fishermen catch the *Photoblepharon* and remove the phosphorescing organ for use as bait in night fishing.

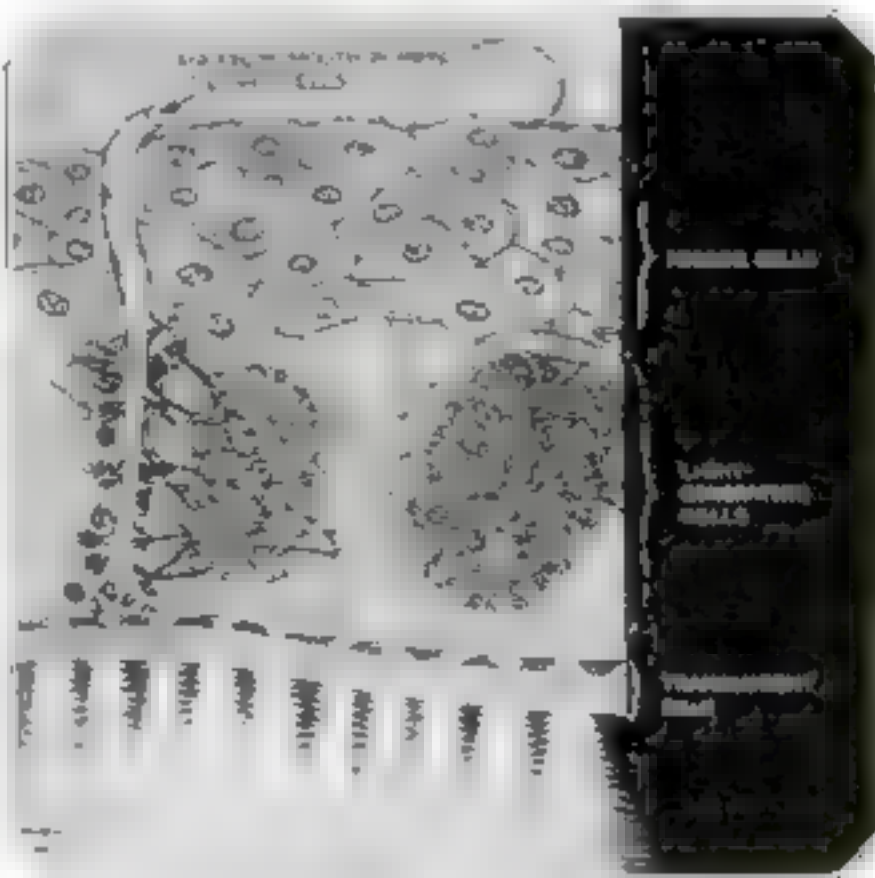


Arrow points to luminous organ

while others confine the light to one side or to a few patches.

One small fish of the herring family generates and burns the light in small cells on the under side of the body. Behind each cell is a reflector of crystals of an organic nature that have the property of reflecting the weak rays of light from the flashing luciferin. The light is prevented from entering the animal's body by a second layer of black pigment cells.

Another luminous fish, which carries the name of "*Photoblepharon*," has a constantly working light cell on each side of its head, under the eyes. The luciferin is secreted in bacteria within the light cells, from which it is forced outward into small sacs just beneath the skin. Pinholes leading to these sacs permit a small flow of water that contains the necessary oxygen to form the light. The fish is pro-



The heatless light organ of the firefly, shown in cross section above, consists of light generating cells immediately under the translucent skin, and a reflecting layer of milky white cells that serves to prevent the light from penetrating the firefly's internal organs. The light cells are supplied with air from the insect's mouth through many branching tubes.

Planes Trap Migrating Grain Pests in Upper Air

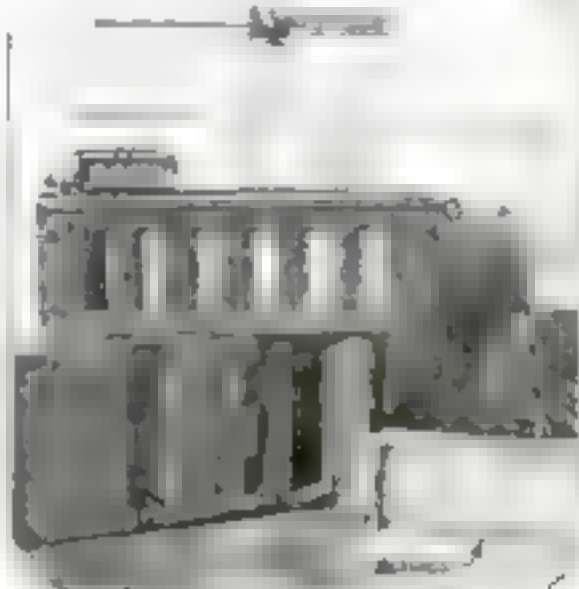
BLACK stem rust, which annually destroys 200,000,000 bushels of growing cereals in the United States and Canada, is being fought by airplanes under the guidance of the United States Department of Agriculture. Heretofore the exact movements of spores from the rust as they are blown about the country by the winds, have been unknown. But now, by examining the air at different levels with spore traps carried in airplanes, it is believed that sufficient data will be secured to permit an intelligent crusade against black rust and similar fungi that attack cereals and other valuable food plants.

Millions Lost Each Year

Black rust is a form of fungus that closely resembles bread mold. The spores—which are the reproducing units—are picked up by the wind from one field and blown miles to other fields, where they attach themselves to valuable cereals and gradually sap the life of the growing plants. The black rust spores thrive best on growing grain that is well nourished and vigorous, thus causing a large decrease in yield. In 1916 it was estimated that the loss to the country from stem rust reached the amazing total of half a billion dollars. The average annual wheat loss alone is estimated at 84,000,000 bushels.

Because rust spores are too small to be detected by the unaided eye, it has been difficult to follow their travels. It is known, however, that the common barberry bush, which flourishes in the North and South, has a direct bearing on the propagation of the fungi. Early in the spring the winter spores germinate and produce smaller spores that infest the

In the spore trap shown below microscope slides inserted in revolving spools are exposed by pulling a trigger wire.



Placed on the wing the spore trap has caught spores at altitudes up to 11,000 feet. Often the slides are exposed by hand, as shown.



How a fungus attacks plum above and potato leaf at right.



barberry upon which clusters of spores are formed. These cluster spores are blown about by the wind until they settle on grasses and grain, where they produce still other species of spores that eat into the fibers and gradually kill the growing plants. It was to secure further data on the reaction between the spores and their journeys through the air from one breeding spot to another that the airplane was pressed into service.

To collect these facts a number of microscope slides, three inches by one inch, are carried on a plane at different altitudes. At each altitude a plate is exposed to wind currents for a definite period. The glass slides are smeared with vaseline to make the fungi stick to the surfaces. After the exposures, the slides are examined under a microscope and the number and type of spores carefully studied.

To facilitate the exposure of the microscope slides and to protect the exposed surfaces, an ingenious device called the "spore trap" has been perfected by officials of the Bureau of Plant Industry.

How the Spores Are Trapped

Six slides are inserted in six revolving wooden spools arranged in a box. At one end of the spools are metal pegs that can be engaged by a ratchet crank operated by the observer from the cockpit of the plane. After the proper altitude has been reached, the observer pulls a trigger wire connected with the ratchet of the trap, and an oil-smeared plate is exposed to the wind stream for periods up to 30 minutes. At the end of that time another pull on the wire turns the exposed plate inward and brings a fresh plate out.

Data gained by study of the plates in the laboratory are expected to indicate the seasons of the year when the spores move in greatest numbers, the reaction of the spores to temperatures and altitudes, the effect of ascending and descending air currents and the general direction of their flight. With knowledge of direction of flight, farmers can be warned in advance of the approach of the fungi and can take protective measures.

Spores of the black stem rust have been captured in large quantities at altitudes up to 8,000 feet, and in a few instances up to 11,000 feet.

Boring Nozzle Cleans Sewers

SEWERS clogged with sediment and debris can be quickly cleared by a recently invented self-propelling nozzle, embodying the principle of the sky-rocket.

The nozzle consists of a rotating spear-shaped head with one small opening in front and a series of larger openings toward the rear. When it is connected with a hydrant, the water strikes diagonal vanes in the nozzle, causing it to rotate. But since the hole at the front is too small for escape, the water leaves through the holes pointing toward the rear. The reaction causes the nozzle to squirm forward.

In operation the nozzle is attached to a standard hose and lowered into a sewer. As soon as it advances and meets an obstruction, the streams of water penetrate and wash away the obstructing mat-



Water, forced through holes in the rear of the whirling nozzle, propels the nozzle through obstructions.

Revolutionary Spring Designs Will Smooth the Roughest Roads

*Inventions to Take the Jolt out of Motoring,
Described by H. F. Blanchard*

WILL the motorist of tomorrow be able to speed along the bumpiest roads in almost perfect comfort, free from worry about broken springs and abused machinery? Will the joys of automobile travel be enhanced by the perfection of new types of springs that will set us free from the main roads and carry us smoothly over the roughest byways?

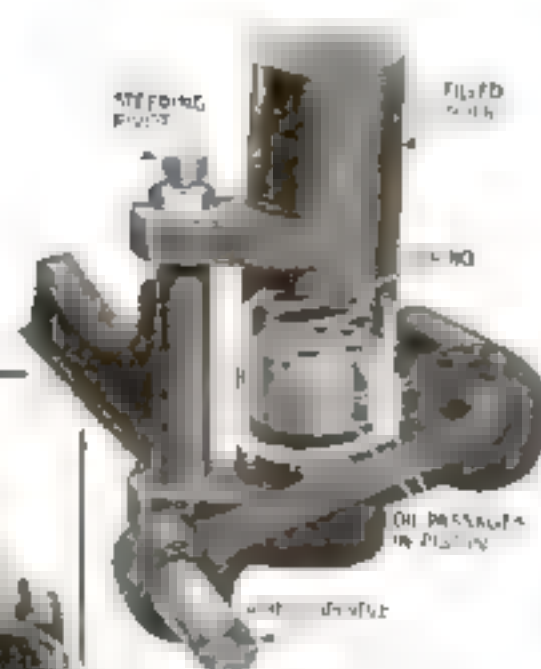
Inventors in all parts of the world are turning of late to the problem of designing springs that will attain such results. Already they are turning out remarkable types of spring suspension that promise to reduce to the minimum not only the chance of breakage, but also the "unsprung weight" on which, to a large extent, depends a car's riding qualities.

One of the most interesting



Unsprung Weight—Enemy of Car Comfort

"UNSPRUNG weight" of a car—the factor that limits its riding comfort—is the total weight unsupported by the springs, and includes wheels, tires, axles, and portions of the springs that move with the axles. In the average five passenger car the total unsprung weight is about 36.5 per cent of the total weight of the car. Fifteen per cent is on the front axle and 21.5 per cent on the rear axle. In this proportion the weight distribution for a car of 3750 pounds is indicated above.



This detail of the front axle of the French car pictured in the left hand column, shows the oil filled cylinder containing a collapsing. Upward movement of the wheel compresses the spring, and sharp rebound is prevented by glycerin in the cylinder which can escape only through small passages in a piston.

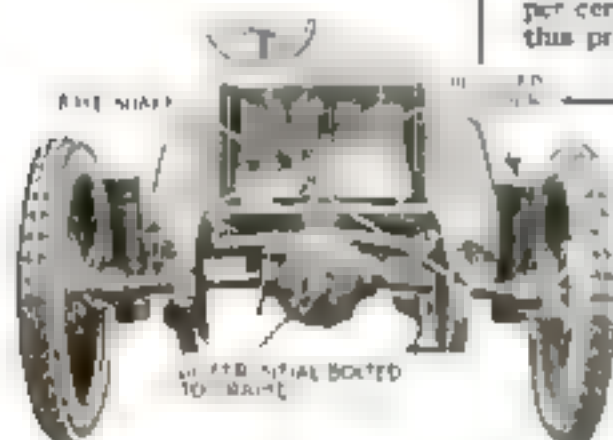
the design is without spring bolts or shackles to wear loose or require lubrication. Among designers there is a growing tendency to eliminate these troublesome parts.

In both the types described, as well as in other new de-

signs, only a small portion of the spring moves up and down with the axle. This is also true of the well-known cantilever spring; but in the half-elliptic spring the majority of the spring mass moves up and down with the axle.

The smaller the weight of parts moving up and down with the axle—unsprung weight, in other words—the better any car will ride. Unsprung weight includes not only the portions of the springs moving with the axle, but also the wheels, tires, axles, brakes, and all parts below the springs and not supported by them. Just as a heavy hammer will strike a harder blow than a light one, heavy unsprung parts, striking obstructions, will transmit a much harder blow to the body than light unsprung parts. This is why the cantilever is often preferred to the half-elliptic spring, and it is also why the two spring types just described are easy riding. The spring weight on the axle is very slight.

In an effort to bring unsprung weight to the irreducible minimum, a French designer recently built an extraordinary car in which axles and springs of the usual type are



How a French designer has reduced "unsprung weight" to a minimum. Each wheel is mounted on a lever arm bearing on a coil spring in an oil filled cylinder. At the rear mounting the differential housing is bolted solidly to the frame, as shown above. Two universal joints are employed in each axle shaft. The front wheel mounting is pictured in the upper right hand corner of the page.

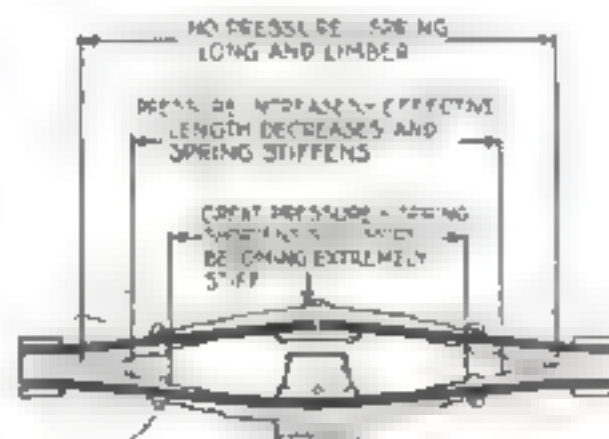
of the new designs appears on an automobile recently built in Australia—a car with springs especially constructed to stand fast driving on rough roads. It has six half-elliptic springs instead of the customary four. On each side of the car three springs are arranged in series under the frame. The front tips of the front springs are secured solidly to the front axle and the rear tips of the rear springs to the rear axle. The adjacent spring ends are linked to each other. The reason for this unusual construction is this:

Fast driving on rough roads demands strong, stiff springs to insure against breakage; but stiff springs produce hard riding unless they are extremely long. In the Australian design, "length" is obtained by linking a middle spring to the ends of the end springs.

In England, an inventor has achieved the same result in a somewhat different fashion,

reasoning that an extremely flexible spring is likely to break, whereas a strong, stiff one causes rough riding unless it is unduly long. To obtain extreme length in this design, the springs run from axle to axle and are clamped solidly to them. Only two leaves are used in each spring, but these are of extraordinary thickness, nearly one half inch in section.

Obviously when a wheel strikes a bump, the whole spring takes the shock, and because of its extreme length it softens the blow with great efficiency. Since the spring ends are clamped solidly to the axles and the spring is mounted in rubber blocks,



The special type leaf spring shown above automatically adjusts itself to any load. The more the spring is compressed, the shorter is its effective length and the stiffer it becomes. Thus it is flexible for the light load and stiff for the heavy load.



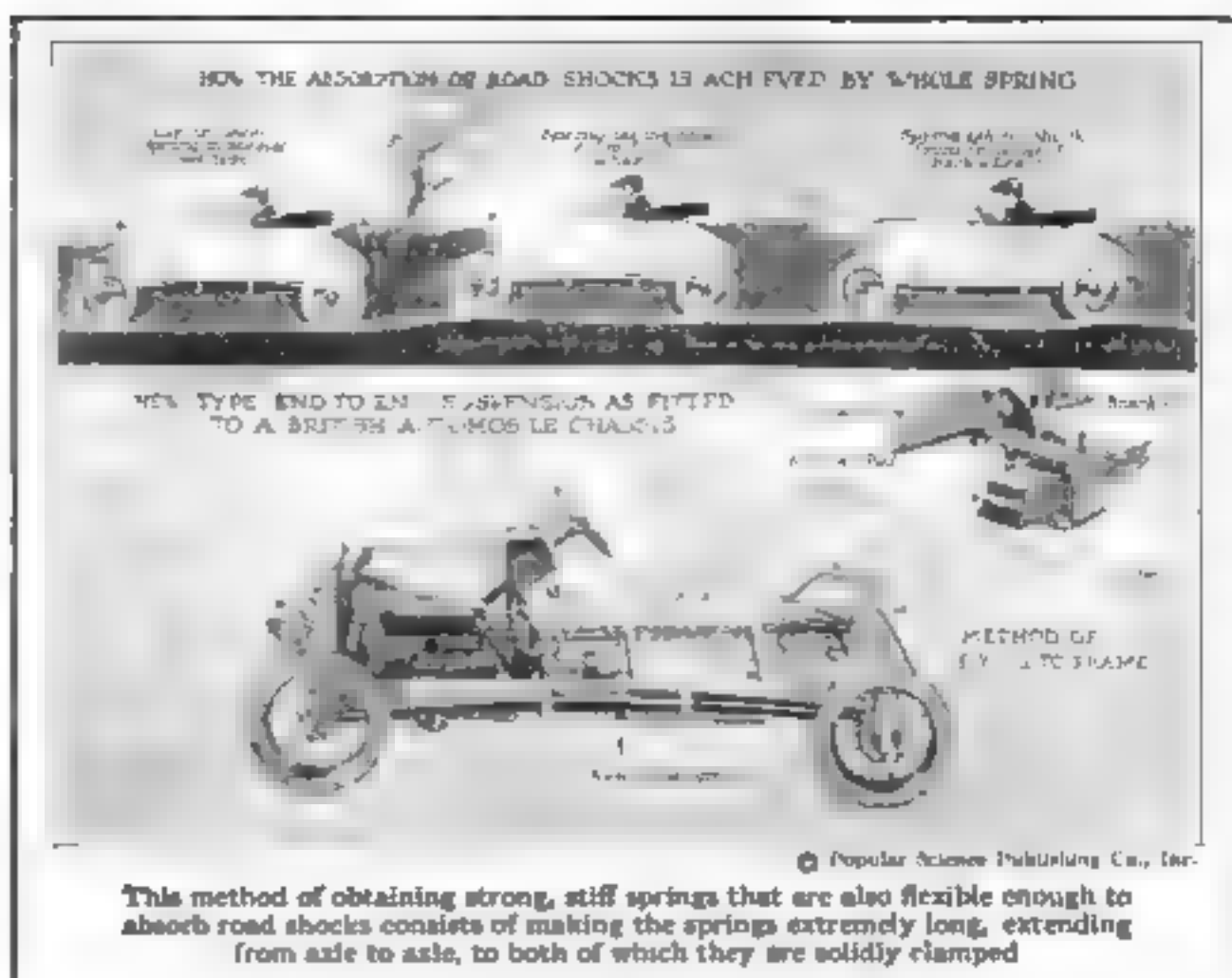
Length and, consequently, flexibility in spring suspension are obtained by linking a middle spring to the ends of front and rear springs on each side of this English car.

entirely eliminated. The unsprung weight includes little more than tires and wheels. In place of leaf springs and axles, the mounting of each of the four wheels is a lever arm, the end of which bears against a coil spring housed in a closed cylinder. To check rebound and damp out oscillations a piston is provided in the lower end of this cylinder. If the wheel is pushed upward, it compresses the spring, but the rebound is impeded by a chamber full of glycerin that can escape only through small holes in a ring set in the piston head. As soon as the pressure is removed, the glycerin is returned to the bottom of the chamber by gravity.

Unsprung Weight at a Minimum

In the mounting of the rear wheels, which is somewhat similar to the front wheel mounting, the unusual feature is that the bevel gear and differential housing are bolted solidly to the rear frame cross member. Since the wheels move up and down while the bevel housing is stationary, two universals are employed in each axle shaft. This design, properly worked out, must develop perfection in riding qualities because unsprung weight is at an absolute minimum.

In the United States an axleless car is now being developed. Unlike the French design just described, leaf springs of a special type are employed. The wheels are mounted on the ends of two leaf springs set transversely at the front and at the rear. The springs thus take the place of the axles.



The mounting of the rear axle mechanism is similar to that employed in the French car. A very light tubular member is used at front and rear to hold the wheels parallel. Another special type of leaf spring, de-

veloped by an American designer, automatically adjusts itself to the load, so that a car with one passenger will ride as well as it will with seven passengers. The spring is strong enough to withstand any blow, yet delicate enough to produce easy riding. Spring bolts and shackles are eliminated with all their difficulties. Paradoxically, these advantages are obtained by simplifying the construction so that this spring may be made more cheaply than existing types. At first glance it resembles a full elliptic, but further inspection reveals that the usual spring bolts that hold the ends of the elliptic type together are missing. Top and bottom spring units are given a reverse curve and resemble a bow. The ends of the two bows are clamped together, so that as the spring is compressed, the ends simply move farther out, thus making spring bolts or shackles unnecessary. The more the spring is compressed or deflected, the stiffer it becomes, because compression shortens the effective length of the spring. Therefore it is flexible enough to provide easy riding with only the driver in the car, and yet stiff enough when there are several passengers in the car. Similarly, if the wheels strike a severe bump, the spring becomes very short at maximum deflection and thus at the moment of maximum stress the spring is at its strongest point.

How to Care for Your Auto Springs

EVERY motorist talks a lot about his tires. Likewise he gives constant thought and attention to his engine. In fact, he's pretty well versed in the ways of every part of his car—except the springs. Just ask yourself the question—don't you neglect your springs—unless or until they break?

Yet if springs were given the care and consideration that tires receive, they would give far better service and would produce greater riding comfort. Both springs and tires are absorbers of road shocks. Tires are merely pneumatic springs that devour the smaller bumps as the wheels roll over the ground; yet they are unable completely to smother the larger shocks. These shocks are transmitted to the springs.

THE man who drives fast over rough roads and fails to slow down for severe jolts may expect his springs to give out sooner than they should.

Similarly the man who overloads his automobile or truck is likely to pay for it in "fagged" or broken springs. Overloads cause springs to sag or "set" permanently—a fact that explains why many cars slope to the rear or slant to one side. A sagging spring is a weakened spring.

Loose spring clips will sometimes cause spring breakage, because they allow play. For that reason the nuts holding the clips should be tightened every two or three months. Play in the front clips usually results in wobbling wheels; therefore, when a slight tremor in your steering wheel tells you that

your front wheels are wobbling rapidly, look to the spring clip nuts.

MOST springs work better when they are lubricated. Lubrication increases their flexibility, prevents rust and squeaking. But remember that some springs are not designed to be oiled. If a spring is very flexible without oil, it is a mistake to lubricate it, for to do so will make it too flexible and it is likely to break. An unlubricated spring is usually stronger than a lubricated one.

Springs may be lubricated in a great many ways. The simplest is to spread oil on the spring sides, allowing it to work between the leaves as the car is used. Oil, graphite, grease, and special compounds all have their advocates. Other things being equal, graphite is better for flexible springs and a light grease or oil for the stiffer ones. Grease and graphite will "stay put" better than oil, while oil is more readily introduced. Spring covers will keep the dirt out.

SPRING bolts should be lubricated faithfully to keep them from wearing too rapidly. On many cars the spring bolts are adjustable so that the play due to normal wear may be eliminated. The ends of some of the spring leaves are usually fitted with rebound clips. If these are missing, the rebound of the spring will be excessive and it may break.

Springs have individuality. Therefore, when a leaf breaks, it is better to put in a complete spring than to put in one new leaf.

Slow Down for Bad Jolts Don't Overload the Car Tighten Nuts on Clips

Air Cushions Replace Steel

In still another recent American design, the resiliency of air is substituted for that of steel. The car is carried on four hemispherical pneumatic cushions, each of which is made of rubber and fabric like a tire casing and is mounted on a circular metal base. Inside it is an inner tube that is inflated to the desired pressure. Each cushion rests on a bullet shaped metal piece called a "deformer." The shape of this member is such that its area of contact increases with the load.

Rubber blocks in lieu of spring shackles have recently been employed by one of the foremost American truck builders and this practice may be expected to become more widespread, since it eliminates the necessity of lubricating shackles, at the same time avoiding wear and rattle.

Science, in Newest Feat, Explodes Atom

How Experimenters, Setting Off Terrific Electrical Charges, Converted One Element into Another

By E. L. Bragdon

WILL some future generation see a giant ocean liner passing the New York-Liverpool run on a bushel of coal? Will our descendants ride in a modern Twentieth Century Limited drawn by an engine consuming only a hod of fuel between Chicago and New York? And will they enjoy the advantages to be available when a whole city can be lighted for a score of years on a bit of radium that could be balanced on a pin head?

Recent exploits of scientists in knocking fragments out of atoms of matter that we have hitherto thought indivisible seem to offer such as these.

And conservative men of science are themselves voicing such dreams. Recently we went around the world that Gerald W. associate professor of chemistry at the University of Chicago, in collaboration with Dr. Irion, had accomplished "the transmutation of elements." What these two experiments really did apparently was to decompose atoms of tungsten into helium and other elements.

Speaking of the significance of this experiment, Mr. Wendt says: "The great promise of atomic decomposition is that means will some day be found to liberate at will terrific energy from common elements. When that happens, the future coal supply need worry no one. It is far off, but a new industrial era can be pictured that makes the coal age seem medieval indeed. And beside that prediction, the prospect of ever transmuting lead into gold becomes of trivial significance."

When we deal with the atom, we are dealing with something so small that it cannot be seen even with the aid of the most powerful microscope. An idea of just how small an atom is, may be gained from the fact that if a hole could be punched in an electric light bulb small enough to let in a million atoms of oxygen a minute, it would take 100,000,000 years to fill the bulb! And yet by flashes of light accompanying the wrecking of an atom, scientists of genius are now able to weigh these particles that are so infinitesimally small as to baffle the imagination!

Two thousand years ago, Greek philosophers reasoned that every par-



The Old Alchemy and the New

CONTRASTING with the ancient alchemist, the modern man of science actually succeeds in converting one element into another.

With apparatus similar to that pictured above, two scientists at the University of Chicago have converted tungsten into gases.

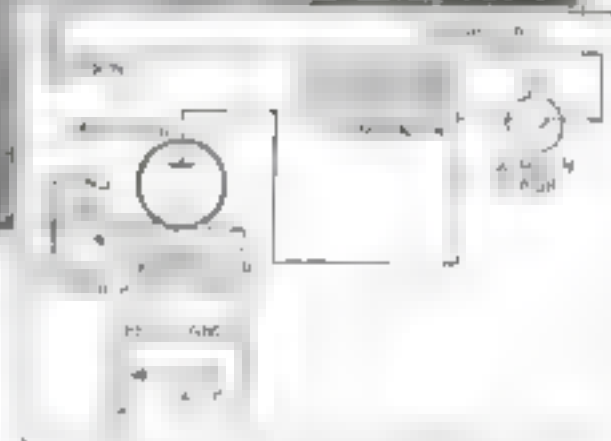


Diagram of the pictured apparatus, of a many days used by Dr. J. A. Anderson, at the Mount Wilson Observatory to produce temperatures hotter than the hottest star.

Electric current is piled up in a massive condenser. Reaching the limit of the condenser's capacity, the current suddenly jumps the spark gap and discharges itself through a fine metallic wire enclosed. As the wire is vaporized, a deafening explosion results.

ticle of matter—solids, liquids, and gases—must have some small unit beyond which it could not be further divided into smaller particles. But since the discovery of X-rays and radium, these speculations of ancient science have been replaced by

actual knowledge of atomic structure. Radium, which gives off its energy unceasingly for 2000 years, is the most familiar example of atomic power. There are approximately 10,000 calories of heat in a pound of coal. A pound of radium contains atomic energy one billion times greater.

When coal is burned, a quantity of useless ashes remains. When radium is broken up by the release of atoms, the residue is lead.

Sir Isaac Newton, father of the theory of gravitation, believed that the atom was a hard, massy particle that could not be penetrated—that it was the ultimate in subdivision and represented the unit upon which all the remaining material was built. But later researches made scientists

Atom Explorers Open Up New Worlds

THE most amazing activity of scientists today is the exploration of the atom. They are opening up a vast world of new knowledge that intimately concerns every other interest you may have, be it radio, electricity, astronomy, medicine, or what not.

But do you understand the methods by which atom explorers are probing these minute solar systems, which boast of relatively staggering distances all comprised within almost infinitesimal space? Do you realize the industrial possibilities of their work?

The above account of recent spectacular experiments in knocking atoms to pieces will illuminate for many readers a new and extremely fascinating realm of science that no well-informed man today can afford to ignore.—THE EDITOR.

believe that the atom is not a solid mass, but rather a sort of solar system of moving parts, consisting of a tiny central particle of positive electricity, surrounded by relatively large particles of negative electricity, called "electrons."

The present excitement over atomic decomposition was stirred up, primarily, by two different series of experiments—those undertaken by Sir Ernest Rutherford, the famous English scientist, and the recent phenomenal exploit of Wendt and Irion, already mentioned.

Sir Ernest Rutherford's experiments had convinced him that the positive electric charge in the atom is concentrated in a nucleus about which negative electrons revolve. These electrons have an estimated diameter of only one hundred thousandth the diameter of the atom. On this basis, if the atom were magnified to 100 feet in diameter, each electron would have a diameter of only one hundredth of an inch. With this knowledge, it is not difficult to conceive that there is plenty of room in an atom for a number of electrons to dodge about at great velocity without collision.

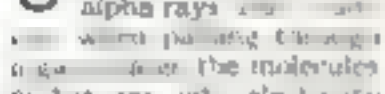
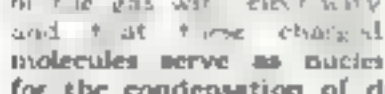
Proof of the Theory

To prove his theory, Rutherford arranged a marvelous experiment on a microscopic scale. In a tiny observation chamber he deposited a speck of radium on a needle point. A short distance away from the needle he installed a screen with a coating of zinc sulphid, and at the opposite end of the nitrogen-filled observation chamber he placed a super-magnifying lens. Between the needle and the sulphid screen he placed a partition with a small hole in the center covered with a sheet of aluminum foil. (See diagram on next page.)

From the radium on the needle a spray of swift alpha particles is being constantly expelled. These particles travel at an initial velocity of 10,000 miles a second, though the distance they travel is short. Their speed is 10,000 times that of a rifle bullet, and their energy, consider-

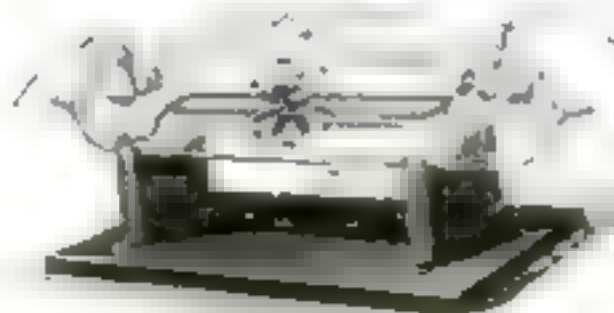
The Invisible Becomes Visible



UTILIZING the fact that alpha rays  were passing through a gas  the molecules of the gas with electricity and that these charged molecules serve as nuclei for the condensation of droplets of water C. T. R.

Wilson, the English scientist, obtained photographs of the paths of atoms in flight which in the words of one scientist, "Lifted the atom from the state of 'necessary but ideal' and transferred it to the real."

Wilson's apparatus consisted of a glass flask fitted with a plunger and filled with water vapor into which a speck of radium was introduced. When the plunger was suddenly withdrawn, droplets were condensed on the charged molecules, and by creating an electric spark at the same instant, he was able to obtain the sharp photograph printed above, showing the tracks of the rays. The bends in the paths of some of the alpha particles indicate collisions with positive nuclei of gaseous atoms that deflected the particles.



This familiar experiment demonstrated that electric current is simply flow of electrons. Passing into a vacuum tube, the current, like a stream of water, turns a paddle wheel.

ing the respective masses, is 400,000,000 times greater. Yet so quickly is their energy released when obstacles are interposed in their path, that this velocity is almost instantly reduced to zero. In Rutherford's experiment, the partition in the chamber was erected at a distance slightly less than 7 centimeters from the needle point.

Passing through the aluminum-covered hole in the partition, some of the alpha particles collided with some of the atoms composing the nitrogen in the chamber. In each such collision the alpha particle knocked a fragment off of the nitrogen atom, and this fragment proved to be an atom of hydrogen. Since the weight of the alpha particle is four times that of the hydrogen

atom, the latter was hurled forward in the path the alpha particle had been traveling. It was, in fact, by the force of the collision, driven against the zinc sulphid screen, which was beyond the range of the alpha particles. Every time one of these hydrogen atoms struck the screen, a flash was produced. These flashes were visible to the investigator with his eye at the magnifying lens. He could count their number and note their paths.

Can Energy Be Used?

In wonderfully delicate experiments of this kind, Rutherford may be said to have achieved atomic decomposition, but on an almost incredibly minute scale.

Just how it will be possible on a large scale to break up the atoms composing a given material, so that the energy thus released can be turned to practical commercial use, is a problem yet to be solved.

The still recent but already famous experiment of Wendt and Irion was undertaken, however, in the hope of pioneering in this field of ultimate commercial utility, following a path different from Rutherford's. Their scheme was to decompose atoms by applying heat, rather than by bombarding them with the tiny projectiles given off by radium, as Rutherford had done. But temperatures attainable commercially, which will decompose molecules of matter, have no effect on the

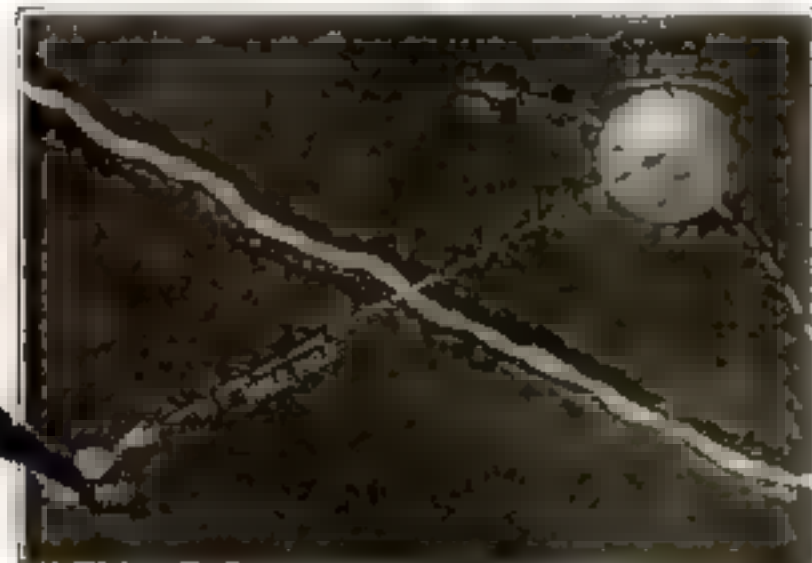
atom. Heat applied to water causes a rearrangement of the molecules, and produces steam. Cold applied to water brings about a different rearrangement, and results in ice. But neither heat nor cold, applied within the limits of minus 269° C. and 4000°, has a tendency to disintegrate atoms. As soon as this fact was established, scientists generally agreed that the disintegrating force, if any were found, must come from within the atom itself.

Yet certain physicists have not abandoned application of the superheat theory. They point to the stars as instances of the effect of tremendous temperatures. Stars, it has been proved, vary widely in composition. The hottest stars seem to contain only the lightest elements, but as the temperature decreases more and more, the heavier elements appear. The very hot bluish stars, with temperatures between 16,000 and 20,000° C., show the predominating presence of helium, while the cooler stars, with temperatures around 5000° C., reveal the presence of heavier elements.

Heat of Stars Is Equalled

Although this star evidence does not definitely prove that atomic decomposition may be effected by extreme heats, it does make it seem a possibility. Hence Wendt was encouraged in his recent spectacular experiment in atomic decomposition at terrific temperature.

Recently, Dr. J. A. Anderson, of the Mount Wilson Solar Observatory, devised an apparatus for obtaining temperatures far beyond any that had previously been considered possible, and matching that of some of the hotter stars, namely, between



The atom resembles a tiny solar system with a minute nucleus, positively charged, at its center, around which negative electrons circulate in wide orbits. The extreme relative smallness of the nucleus and the distances in the tiny system may be realized from the fact that if the orbit of the electrons were half a mile in radius, the electrons would have diameters of five feet, while the nucleus at the center of the system would be about the size of a walnut.

A Spectacular Collision of Atoms



UNDERSTANDING of the famous experiment of Sir Ernest Rutherford in knocking atoms of hydrogen from nitrogen atoms is simplified by this diagram. From radium on the needle point at the left, swift alpha particles are constantly shooting out. Through a small hole in a partition, the particles, impelled exactly seven centimeters by their own energy, pass into a dark, nitrogen-fueled chamber, where

just before reaching the limit of their flight they collide with nitrogen atoms. At each collision, an alpha particle knocks off hydrogen atoms, which are hurled against a zinc sulphide screen at the extreme right. Each impact produces a flash. Thus the screen glows with points of light, which may be studied by means of a magnifying lens at the end of the observation chamber in which the experiment is conducted.

20,000 and 30,000° C. The high temperature was produced in a confined volume and for a very small fraction of a second, yet from it have been secured important data on the gaseous content of stars.

The method consists in charging a massive electrical condenser with a current of 30,000 volts pressure, and then rapidly discharging this large quantity of energy under high pressure through an extremely fine metallic wire. A violent explosion results, as the wire is vaporized. During the first 1/800,000 of a second the light emitted was 200 times as bright as sunlight, according to determinations made with a rotating mirror. The pressure momentarily developed was between 50 and 100 atmospheres, or in the order of 750 to 1500 pounds a square inch. The noise of the explosion was so loud that the ears of observers had to be protected. When the wire was exploded in a glass vessel, the latter was shattered into tiny fragments. When the explosion was conducted within a glass tube, under water, the wire completely disappeared, and the tube could be found only as an unrecognizable powder.

Paper Torn without Scorching

Another experiment demonstrated how brief a time was involved in the explosion. The fine wire was wrapped in thin tissue paper, and the condenser discharged through it. The paper was torn to shreds, but no signs of scorching were discovered.

It was a similar experiment in vaporizing a piece of wire with an electrical discharge of enormous horsepower that Wendt and Irion carried out in the laboratories of the University of Chicago. They used a home-made transformer of 100,000 volts, operating from a 220-volt alternating current circuit. It was connected so that its high voltage output was rectified by a vacuum tube device known as a "kenotron." The electrical condenser into which this high voltage direct current was fed consisted of 100 plates of special Florentine window glass, cast in paraffin. The rupturing voltage of the condenser was determined by the width of the spark gap, which was con-

nected in series with the wire to be vaporized. For the actual experiments, short sections of tungsten wire, varying from .03 to .001 millimeters in diameter, were used.

The wire was exploded in a bomb, so that the gases could be captured for later analysis. Contamination by other elements and gases was prevented by conducting the explosion in an atmosphere of pure carbon dioxide gas at atmospheric pres-

sure. After the explosion, the carbon dioxide was absorbed in potassium hydroxide.

In another method used by Wendt and Irion, the explosions were produced in the highest attainable vacuum, and the resulting gases examined in a spectroscopic tube attached to the vacuum chamber. This method was found to be more satisfactory, but difficult to manipulate.

Helium Is Predominant

When the vacuum method was used, the bulb in which the wire was exploded was thoroughly exhausted for 15 hours, while being baked in an electric furnace, with a current passing through the wire to keep it at white heat. The wire was then exploded and the gaseous products collected, after which they were analyzed with a spectroscope. In every instance, the spectrum showing helium stood out brightly.

The investigators appreciated that there were several possible sources of helium other than the decomposition of tungsten, but neither of them could account for the very large volume of helium, unless it were produced by the conversion of nearly half the tungsten in the wire. In more than a score of explosions, the volume of gas averaged over a cubic centimeter. If this gas were all helium, it would account for between 25 and 50 per cent of the entire weight of the wire exploded.

"Atomic decomposition on a much larger scale than ever before attempted seems thus to have been attained," says Mr. Wendt.

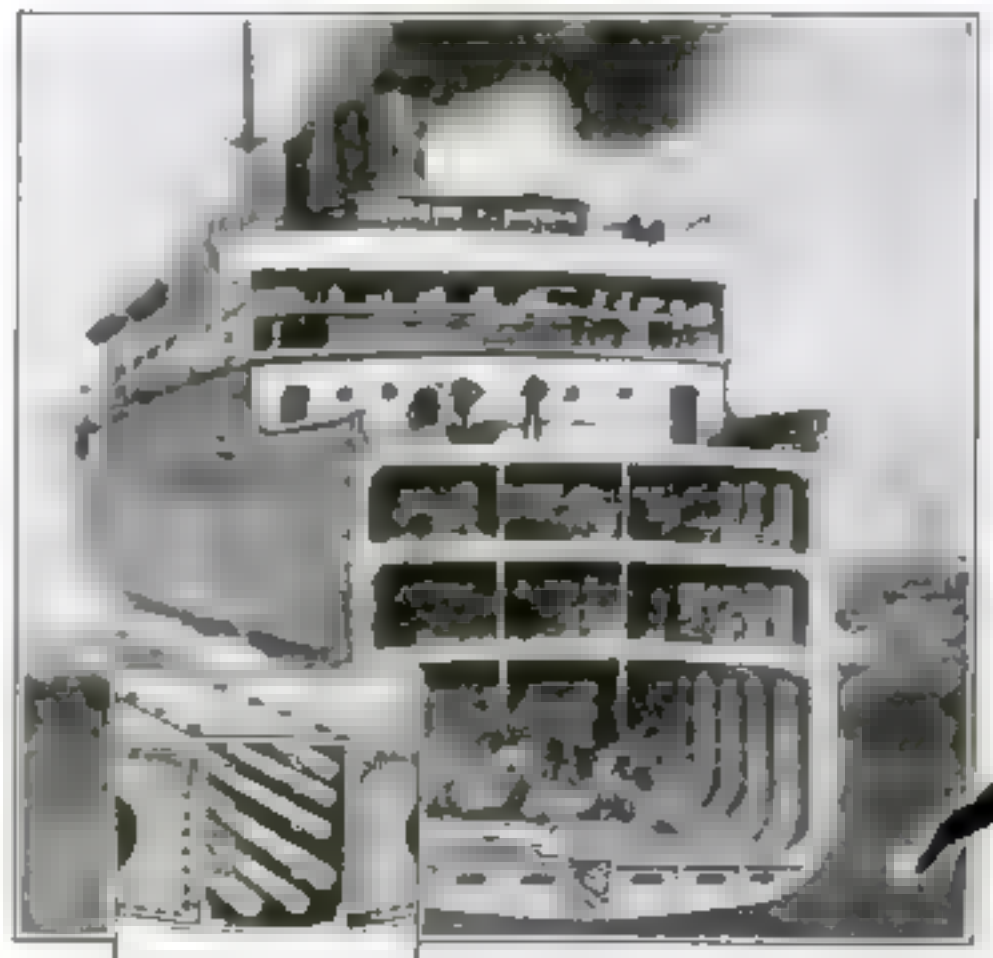
It is conceivable that ultimately it will lead to a synthesis of the smaller atoms into larger ones, and when that becomes possible the manufacture of any metal from hydrogen and helium and from other metals will be within range—the transmutation that fascinated the mind of medieval baron and alchemist."

Tunnel in Keel Holds Ship's Pipes

BY INTRODUCING a heavy steel box girder into a ship's keel, a British inventor has provided a water-tight duct or tunnel in which the ship's piping can be placed without piercing the various compartment bulkheads. Besides being easier to lay, the pipes can be reached and repaired readily, even at sea, which is not the case with usual methods of marine pipe-fitting.

Many pipes have to be laid almost from end to end of a ship below the water line, and where these pipes pass through the bulkheads, water-tight joints and elaborate arrangements of valves have to be provided to insure that each compartment is water tight independently of its neighbor. Such joints must be frequently examined and tested, as they are apt to become loose from straining of the hull in heavy seas.

It is to overcome these objections that



How the pipes are laid in a water-tight tunnel along the ship's keel.

the duct keel has been introduced. The floor of the duct is on the bottom "skin" plates of the keel. In the case of a double bottom, the top of the duct may be level with the upper plates, but the duct may also be provided in a single-bottom ship.

Coil and Phone Locate Trouble on the Line

WHEN an electric cable short circuits—at any one of a thousand possible points under miles of city streets—a device consisting of a high-frequency coil and a telephone enables the "troubie-shooter" to locate the break



Coil and phone used to locate breaks

within a few feet, and so withdraw the broken length of cable from the nearest manhole without loss of time.

The location of the break is determined by the difference between the sound on one



Holding the exploring coil on the cable, the linesman traces trouble

side of the trouble, and that on the other when the exploring coil is held upon the wire. The tone of the signal on the station side of the burn-out is deep and full with a certain definite beat, and the noise diminishes as the break is approached. On the other side the sound is shrill and faint, and the beat is different.

In the operation of the instrument, a current of about 110 volts and 50 amperes is sent over the broken line from the central station. This induces a slight current in the exploring coil, producing the sounds.

Dial Gage Tests Depth of Piston Ring Grooves



Movements of the measuring plunger are recorded by the dial pointer

Horse and Giant Hammer Pull Stumps



PULLING stumps with a "giant hammer" was one of the simple land-clearing methods recently demonstrated by the University of Minnesota. By the use of equipment available to most farmers, land was cleared of stone and stumps in quick time, while a group of farmers watched the operation and learned how to increase the productive acreage of their own lands.

The device is a combined lever and fulcrum resembling a large hammer.

The part of the lever nearest the hammer head is chained tightly to the stump, while a horse is hitched to the end of the "handle." When the horse pulls, the upright pole turns slowly on the rounded log to which it is attached. The leverage represents an upward pull on the stump of approximately five tons. This is enough to break off the roots well below the surface and drag up the stump, and all without the use of expensive and dangerous explosives.

Seamstress' Knife Holds a Tape Measure

A SPECIAL knife for ripping seams that also contains a steel tape measure, has just been invented for the seamstress.

The tape is held in the back of the handle, in a small circular case with a spring rewind, exactly like the tape measure used by a surveyor. It is divided into inches on one side and centimeters on the other.

The knife has two very useful blades of standard form and size.



The tape measure is unwound from a small reel in the knife handle



Fire Victims Revived by New Oxygen Mask

INVENTED for the resuscitation of gassed soldiers, an inhalator devised by Prof. Yandell Henderson, of Yale University, is now being used to revive victims of fire and industrial gas poisoning. Compressed oxygen is fed from a tank into a breathing-mask and forced into the lungs of the sufferer.

In preliminary experiments it was discovered that human lungs are influenced by chemicals dissolved in the blood which act upon certain nerve cells in the brain. The vigor with which you breathe, for example, is at least partly dependent upon the amount of carbon dioxide dissolved in the blood.

For this reason, in the rescue apparatus a carefully regulated amount of carbon dioxide is mixed with oxygen to stimulate the lungs. Although unconscious, the patient will take deep breaths that flood his lungs with oxygen and usually he will soon be revived.

RECENTLY the United States Department of Agriculture recommended oaks as the best trees for street planting. Elms are second choice, and sycamores third. Maples are considered less desirable.

Electric Lights for Your Country Home



IT IS now possible to procure a portable home lighting plant that weighs only 100 pounds exclusive of the storage batteries, and has an output of from 400 to 500 watts, sufficient to light thirty 20-watt lamps at once.

Power is supplied by a two-cycle engine burning gasoline or kerosene. The engine is provided with a self starter similar to those that are used in automobiles.

The engine is started and stopped by pushing a button in a special switch-box. The machine may be used to charge auto batteries.

Roadside Sundial Becomes Novel Advertisement

SUNDIALS as roadside advertisements have been designed by G. D. Love, of Coshocton, Ohio, who has recently perfected a simple method of orienting a dial so that its face will be vertical and the time accurate.

The usual sundial's face is set horizontally and the gnomon pointing to the Pole star; but Mr. Love's device works on the opposite principle. The dial is hung vertically, facing as squarely as possible toward the south, and attached to the supporting post by a bolt through the center. Before this bolt is tightened, the dial is turned so that the shadow indicates the correct time at the moment the dial is erected, and this insures that its reading will be accurate thereafter.

The novelty of the device and its usefulness to the passing automobilist, call attention to the advertisements painted around the circumference, the purpose for which this sundial was first used.



Hung vertically on a post, the dial faces toward the south

"Phantom Band" Plays Radio Music

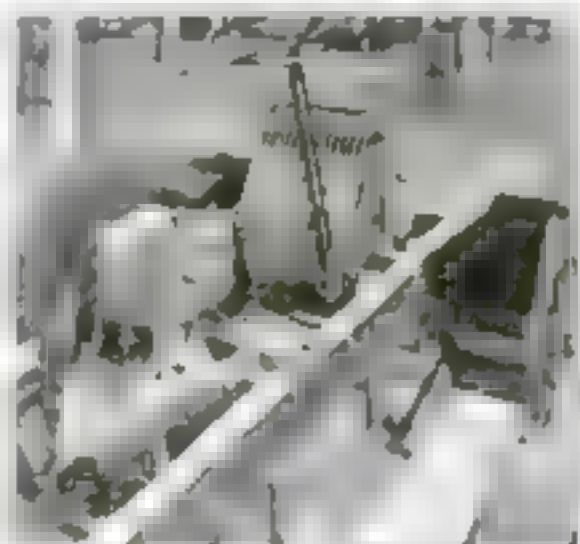


IN A recent parade of engineering students at the University of Wisconsin, a "phantom band" produced music without instruments. The only horn in evidence was a large morning-glory amplifying horn

connected with a radio receiving set hidden under a covering on a stretcher carried by members of the band.

The concert itself was given at the radio broadcasting station of the university.

Steam Truck Develops 750 Horsepower



How boiler and engine are mounted on the steam truck chassis

A JOURNEY by steam truck twice around the globe without lifting the hood to adjust a single part is the goal of the makers of a new machine manufactured by automotive engineers of Chicago.

In the new car the boiler is placed under the hood with a two-cylinder vertical steam engine directly behind it. The engine is connected with the rear wheels by the usual propeller shaft.

Large capacity and simplicity are outstanding advantages of the boiler, which resembles the usual sectional boiler with incased tubes, except that alternate sections run in opposite directions. The headers from all sections are connected with a single steam drum at the top of the boiler.

The firebox, with its single hole nozzle for atomizing kerosene, distillate, fuel oil, or gas oil, is suspended beneath the boiler. In order to give the burning fuel sufficient time to complete the combustion, the nozzle carries the mixture into the circular firebox at an angle that causes the flame to travel in a circle of six or seven feet. A small electric motor of one thirtieth horsepower drives the pump that delivers air to the nozzle. A spark plug lights the flame.

When the steam pressure reaches 600

pounds, the fire is automatically shut off and is not relighted again until the pressure drops to 575 pounds. The boiler tubes of the steam car have been tested by heating them red hot and pumping cold water through them.

All the accessories—boiler feed pump, fuel pressure pump and condenser pump—are hooked as a unit to the engine shaft. Reports from power tests state that the steam truck has a pulling power equal to 16 times that of an ordinary 50-horsepower truck engine.

Derrick Lifts Wagon Load over Ship's Hold



THE contents of 10 wagons can be unloaded into a ship in the time it would take four laborers to unload one wagon by hand, it is claimed, by a newly devised method in which a large derrick lifts the loaded wagon, driver and all, and swings it into position above the deck of a vessel.

With the wagon suspended over the ship's hatch, the driver releases locks that hold the bottom pieces in place. These bottom gates swing open under pressure of the load, and the contents of the wagon pour into the vessel's hold. Since the load is handled only once, labor charges are materially reduced.

Dollars from Waste Chips

How a Big Electrical Plant Salvages Vast Pile of Sweepings

Centrifugal separators, shown below, reclaim from chips and turnings the cutting oil used on metal-working machines.

EIGHTY million pounds of waste metal, passing every year through the doors of the by-products building of one of the largest electrical manufacturing concerns in the United States, is transformed into useful material of tremendous value.

This 40,000 tons of waste, on the way to salvaging tables, represents in itself little more than a large potential freight bill or the cost of a scrap heap. But by the time modern salvaging machinery has done its work, this same waste has been sorted, separated, and transformed into potential dollars.

How Sweepings Are Sorted

Sixty-five million pounds are sold yearly for about \$1,000,000, while 15,000,000 pounds are returned to the shops to be used again—and thus not a pound of this huge mass of material is thrown away.

To sort and classify such vast quantities of miscellaneous material remarkable machines are necessary. By means of electromagnetic separation of chips from metal turnings, for example, it is possible to get the utmost value from sweepings. As these chips reach the by-products building, copper, brass, and steel are indiscriminately mixed. Twenty seconds later they have been sorted and loaded into barrels.

At the entrance of the building the chips are dumped into chutes, and as they slowly slide toward the floor, they pass beneath three revolving disks made of a series of electromagnets. These pick out all the iron and steel chips, which are scraped off the magnets by a rod as the disks revolve.

The non-magnetic materials slide down the chute into their own special bin. Sorted in this manner the metals bring a higher selling price.

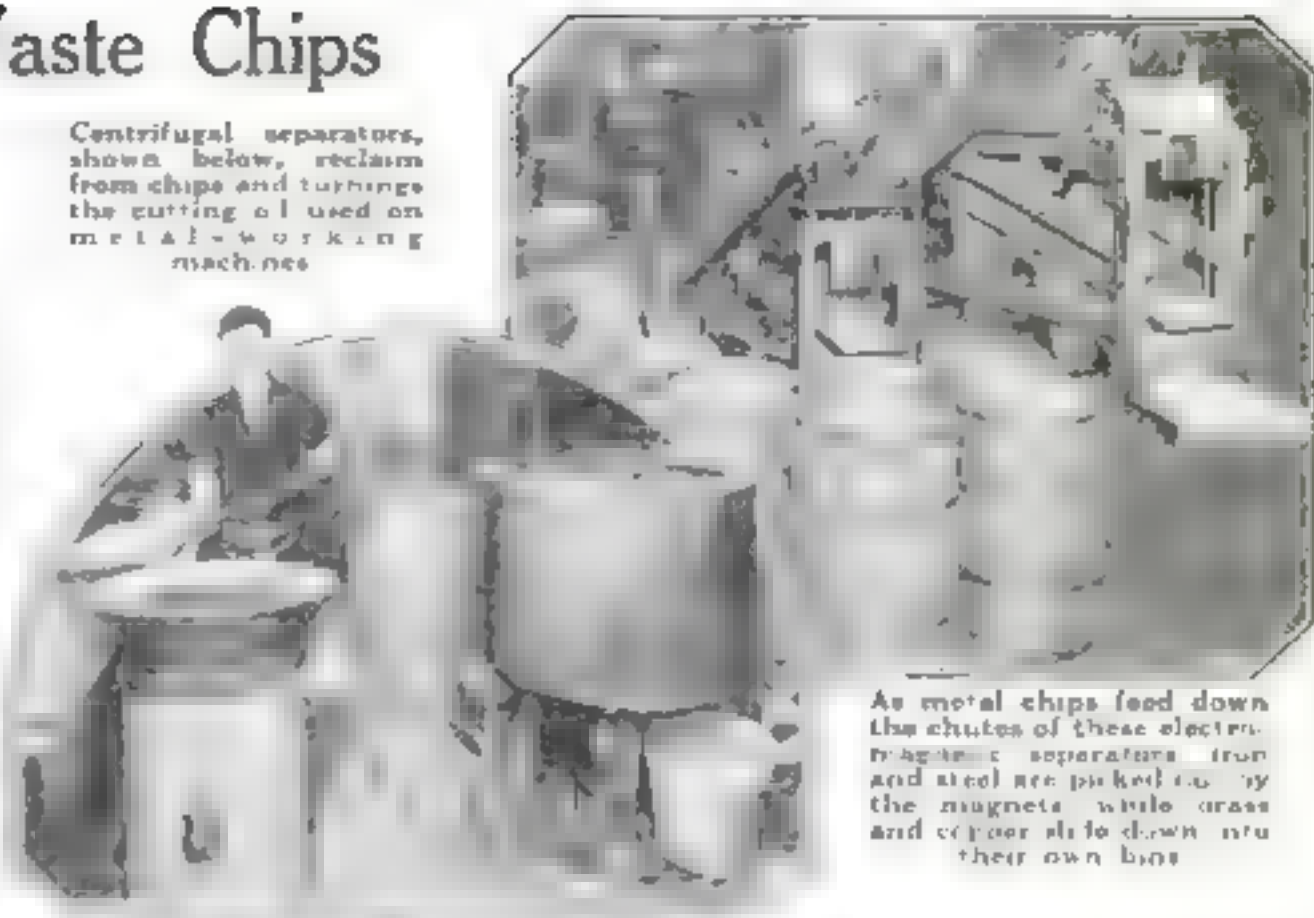
Metal chips that come from machines operated with cutting oils, are put through a centrifugal oil extractor before passing to the magnetic separator. The oil thus collected is mixed with new oil and goes back to the shops, while the chips are cleaned and dried sufficiently to be magnetically separated.

This thoroughness in reclamation is characteristic of all departments of the big plant. Waste paper, for example, is first bound into scratch pads, which, having served their purpose, are put through a slitting machine to destroy any private memorandum, and baled and sold. Rope and worn belting are examined, and any

sections still durable are cut out for use on smaller machines. Waste Babbitt scrap is recast into small pigs and used in future production. The scope of the salvage operations may be realized from the fact that the capacity of the Babbitt furnaces is 12,000 pounds a day.

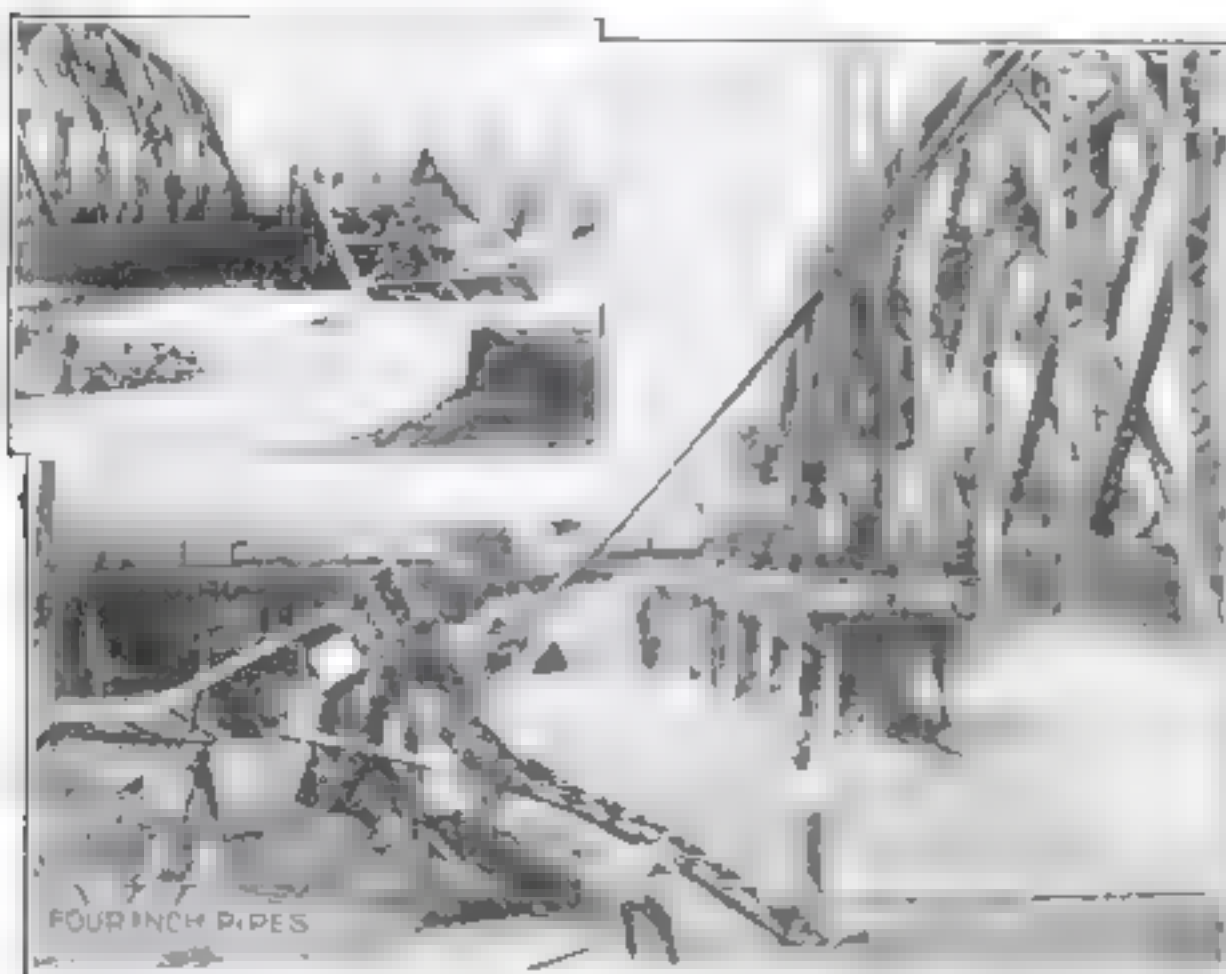
When tools in any of the shops become dull or broken, they are never thrown away, but are resharpened or repaired time after time and are thus kept in service. Worn lathe and planer tools are sent to the blacksmith shop, where they are repointed. Eventually they are returned to the manufacturing departments in good condition.

The laboratories, for which this great concern is noted, assist in the "leak-plugging" process. Scrap tungsten, platinum, and molybdenum, with numerous other metals are all reclaimed.



As metal chips feed down the chutes of these electromagnetic separators, iron and steel are picked out by the magnets, while brass and copper slide down into their own bins.

Dynamite Lifts Wrecked Bridge that Cranes Couldn't Budge



Into four-inch pipes driven through the tangled steel network, as shown at the left, heavy charges of dynamite were dropped, while huge cranes stood ready to haul on the exposed structure when the charges were fired. Inset shows the explosion that lifted the entire bridge framework.

WHEN the Arkansas River broke from its channel and wrecked the business section of Pueblo, Colo., one of the victims of its fury was a railroad bridge over the stream.

For weeks after the flood, the old girders and steel frames of the ruined bridge remained in the river, collecting floating debris. When wreckers attempted to remove them, heavy cables snapped like twine without budging the steelwork and as a last resort dynamite was tried with success.

Four-inch pipes were driven straight down through the twisted mass, and into them were dropped heavy charges of dynamite. Monster cranes were hooked to the top of the mangled bridge ready to haul when the explosives were detonated. When the charges were fired, tons of debris were hurled into the air, but the bridge was barely shaken, although somewhat loosened.

In the next attempt, more pipes were sunk in and around the bridge and into them were dropped more powerful charges of dynamite. Extreme care had to be taken because only 25 feet distant stood another railroad bridge that carried all the traffic across the river.

When the new charges were set off, the entire framework of tangled steel was fairly lifted from the stream four or five feet, to drop back into a position where it could be snatched with ease by the same cranes that had failed before. About half a ton of explosives was used at a total cost of little more than \$300.

Wire Coil Is the Hand on the Throttle

Driverless Locomotives, Plunging Toward Each Other on Single Track, Stop Themselves in Time to Avoid Collision

By P. J. Risdon

IS A simple combination of wires, coils, and levers more to be trusted than the trained brain of a human being?

This was the question in the minds of railway engineers after watching the recent demonstration in England of a new type of train control on a little branch line of the London, Brighton and South Coast Railway.

What they saw were two locomotives, rushing toward each other on the same track at top speed, without an engineer in either cab to control them. When a terrific head-on collision seemed almost certain, suddenly the whistles of both engines sounded, steam was cut off, and the grinding of the brakes was heard as the two locomotives pulled up just in time to avoid hitting. These engines stopped of their own accord, simply because they were approaching each other on the same line! Not a whistle, throttle, brake lever, or handle was touched by anybody.

It seems like mechanical intelligence on the part of the locomotives, does it not? Yet these were no super-locomotives—just ordinary ones that for many years had performed their monotonous duty up and down this line.

Train controls designed to act when the human brain fails have been in process of development for many years, but the so-called "Angus" type, demonstrated in Eng-



Two Hundred Lives a Year

IN THE years 1918, 1919, and 1920 more than 3000 train collisions occurred on the railroads of this country, causing the death of 635 passengers, injury to 6240, and property damage to the railroads themselves of nearly \$7,000,000. Automatic stops would have prevented a majority of these tragedies, according to experts on the subject. The railroads, on the other hand, claim that no machine can ever displace the human element in transportation. It is a fact that no device has yet been perfected that entirely eliminates the supervision of a human brain.

It would cost American railroads about \$6000 a mile to equip their 253,000 miles of track with an automatic control system of the kind described in the accompanying article. Whether such a system would prove sufficiently successful, under the severe railroad operating conditions in the United States, to warrant the expenditure of a billion and a half dollars, is a question that is being studied by transportation authorities.

land, is said to be positive in action and not dependent on the judgment of the engineer or a remote signalman.

A small weight acting through the simple force of gravity is the heart of the system. When something goes wrong—a broken rail or a mistake in signals—this weight drops and sets in operation the throttle, air brake, and whistle.

During normal progress of the train the weight is held up by a magnet supplied with electricity from coils suspended between the drive wheels directly over the rails. The current in these coils is produced by "other" electric currents which are flowing continually through the rails when the track is clear. These alternating currents, in passing through the steel rails, radiate delicate lines of magnetism. If a coil of wire is brought near these lines, a minute electric current is produced in the coil and is guided to the controlling mechanism of the automatic stop.

As long as the current flows in the rail, producing the accompanying current in the coil on the engine, the magnet will hold up the weight. But if the track current disappears, due to a break in the rail, to a faulty signal, or to the desire of a signalman in charge

of the section, the magnet is no longer supported by the induced current, and the weight drops, shutting off the steam, blowing the whistle and applying the brakes.

Since there is no contact between rail and engine coils, the currents that appear in the latter are far too weak in themselves to operate directly an electromagnet. They are amplified to workable intensity by a sensitive relay that operates like the trigger of a gun. A comparatively slight movement of the relay releases a much greater amount of electrical energy into the magnet winding.

In preparing a railway for this system of train control the track is divided into sections or lengths, depending on the kind and amount of traffic. All the rails in each section are connected at their ends by copper wires, or rail bonds, but the rails at the section ends are insulated from each

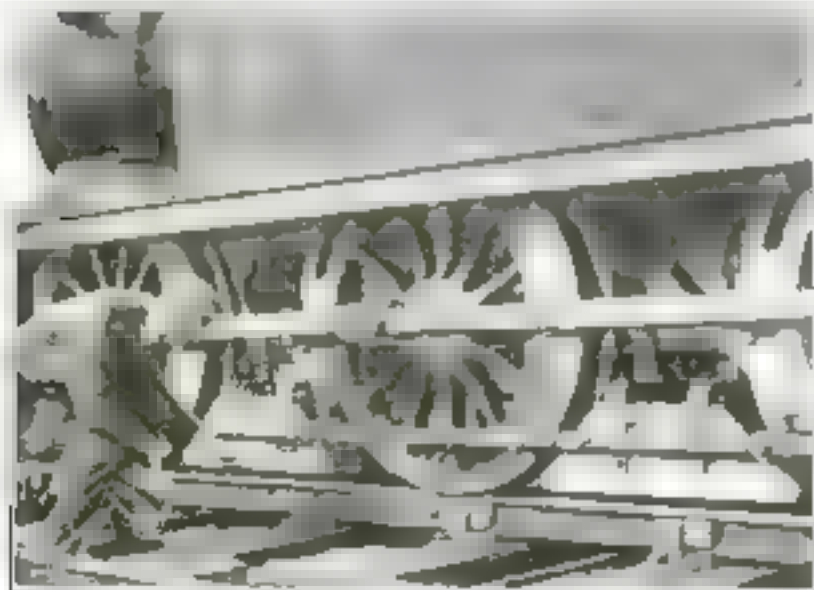
other. The terminals of each section are connected with a switch in a switch tower and from there with a low-voltage alternating current supply system. By these switches the operator can send current from the supply line out through any section and then back to the supply again.

It may appear from the foregoing that any section of track is clear or blocked at the will of the signalman. This is not strictly true, since the automatic stop works in conjunction with the interlocking signal system, which also is automatic. The operator can throw the switches only when the trains are in certain locations with respect to the guarded sections.

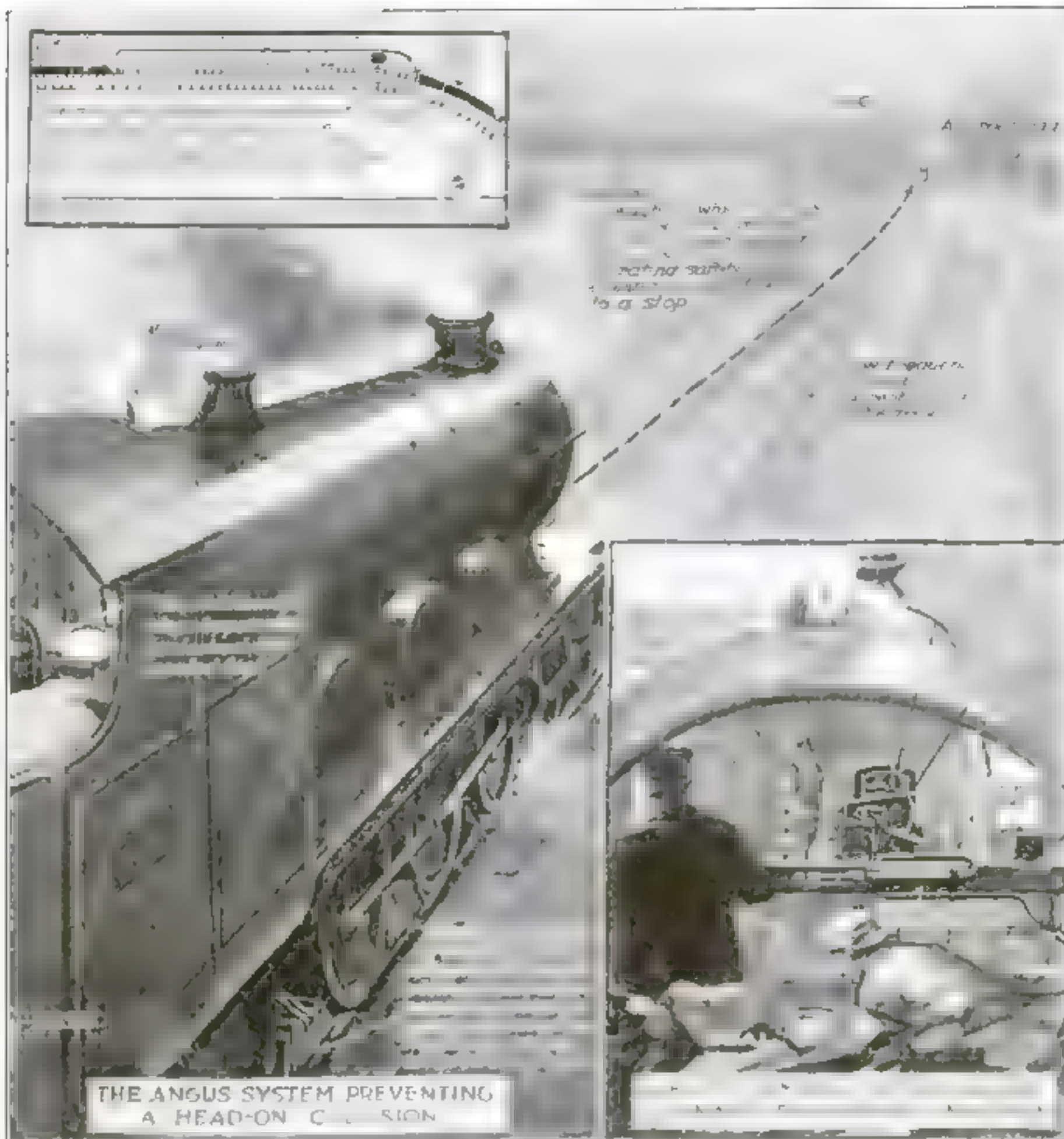
Causes of Train Collisions

A large proportion of railroad collisions has been traced to a sudden lapse of brain action on the part of the engineer. Dazzling headlights from oncoming trains have likewise been responsible for momentarily blinding the man at the throttle and causing him to pass a block signal set against his train. Such things could never happen with the new system of train control, according to reports. If an engineer failed to heed a block signal, the "dead" rail in the dangerous section of track would automatically take the control of the locomotive away from him and apply the brakes without his assistance.

Block signals depend for their effectiveness on the vision of the engineer. In fogs and blinding storms, the strain on the engineer as he attempts to pierce the gloom



Electric currents flowing through the rails when the track is clear, produce a minute current in inductance coils shown suspended in buses between the locomotive drive wheels. From the coils this current is guided to the mechanism of the automatic stop.



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Illustration by E. C. Smith

Leading American railroad officials predict that the ultimate automatic train control will be a derivation of the induction principle employed in the Angus system, successfully tested in England, which is described in detail above

to read the signal is severe. With a locomotive controlled by automatic stops the trains can proceed on regular schedules unmindful of the weather.

The number of train collisions in the United States in recent years has led the Interstate Commerce Commission to take action to compel 49 of the principal railway companies to install automatic train stops or train control devices between designated points on their main lines.

But so severe are the operating conditions of railroads in the United States, with their long reaches and variability in climate, that the perfection of a suitable train control is a slow task. To be pronounced a success, train controls must not lend themselves to tampering by track walkers. They must be inconspicuous. They must withstand the rigorous winters of the north, with the drifting snow and sleet, and they

must be immune to the constant pounding of heavy trains.

One prominent railroad in 1912 offered a prize of \$10,000 for a device that would be suitable for installation along its lines.

During the past 10 years over 1400 inventions have been given a trial without finding one that was satisfactory. Each one had its points of merit which were in almost every case countered by killing weaknesses.

Kiddies' Auto Runs on Storage Batteries



A CHILD'S automobile that resembles "Daddy's" car, even in details, recently created a sensation on the streets of Berlin. It is a real automobile and will run 25 miles under its own power.

The car is driven by storage batteries and an electric motor. The usual fittings—the gear shift, instrument board, and lamps—are exactly the same as those on a high priced gasoline car except for their diminutive size. Automobile spring suspension has been adopted throughout.

Signal Lights Indicate Vacant Theater Seats



THEATER patrons will appreciate the seat signaling system perfected by W. L. Guerin of New Orleans. The device is a small leather box suspended from the shoulder of the usher and containing a double horizontal row of blinker buttons.

The top row contains five white lenses and the bottom row five red ones. When seats in any part of the theater are vacant, the signal is flashed back to the head usher by lighting up the proper blinkers. Red lights mean that two adjoining seats are vacant; a white light that single seats are awaiting patrons.

Dry batteries for lighting the minute bulbs are in the signal cabinet.

The A-B-C of Electric Wiring

THE Bible of the electrician—the National Electric Code has been rearranged and simplified under the title of, "The Code at a Glance," by H. S. Wynkoop (National Association of Electrical Contractors and Dealers, New York). The book—which covers all the code requirements for electric wiring for heat, light, and power—is published in pocket size.

Tandem Engines Convert "Flivver" into Racer



BY PLACING two engines in tandem and increasing the wheel-base length of his car to 139 inches, H. W. Cochran, a speed enthusiast of Coatsville, Pa., recently converted his Ford into an eight-cylinder, streamlined racer.

The engine and fittings are all Ford

Cable and Derrick Aid in Painting Dome

AN INGENUOUS method of painting the interior of a huge dome so that every part of the surface is accessible to the workman has been devised by the superintendent of a San Francisco department store.

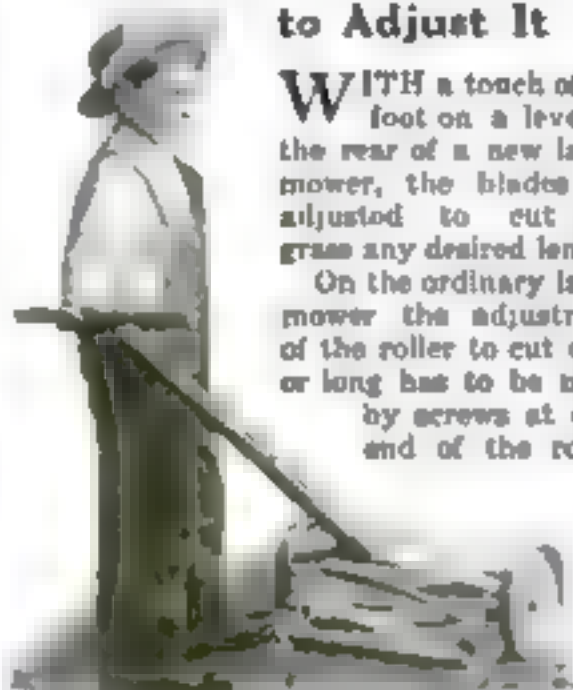
A steel cable is dropped from the center of the dome and guyed securely from each side. At the base of the cable a light weight derrick is constructed with a length equal to the distance to the contour of the dome. A comfortable seat is slung at the boom end for the artisan. Directly beneath him a cloth floor catches all dropping paint.

When the workman desires to change his position, the long arm of the derrick is



elevated and swung around at the same time, placing him in the most convenient position for the work, no matter in what part of the dome.

Kick Your Lawnmower to Adjust It



WITH a touch of the foot on a lever at the rear of a new lawnmower, the blades are adjusted to cut the grass any desired length.

On the ordinary lawnmower the adjustment of the roller to cut close or long has to be made by screws at each end of the roller.



Tiny Flashlight Aids the Camper to Shave

FOR campers who prefer to shave at night, a French inventor has originated a tiny flashlight small enough to fit inside the box of a shaving set. The batteries are strong enough to give a brilliant light for 10 minutes. By attaching the flashlight on a flexible rubber cord, the light may be moved from one side of the face to the other. The shaving set is small enough to fit in a man's coat pocket.

U-Shaped Clip Guides the Blind in Writing

A NEW metal writing tablet, of which the essential feature is a wire guide for the pencil, enables the blind to write legibly. In the past, blind persons able to write ordinary script have had difficulty in keeping the lines even without some means of guiding the hand.

The new invention, by M. J. McNeill, of Seattle, Wash., consists of an aluminum base with a notched bar running down the left side to give even spacing. A U-shaped wire clip guides the blind man's pencil.

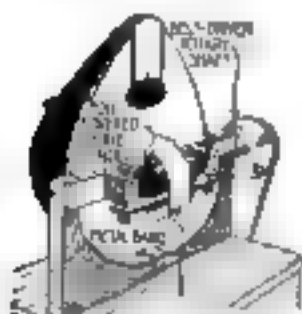


The wire clip guides his pencil

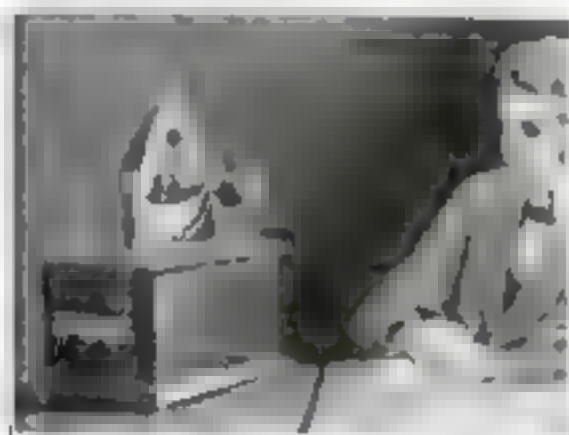
Loudspeaker for Radio Is Made from Mandolin

A LOUDSPEAKER for the radiotelephone can be improvised from a mandolin by the application of a discovery that has been recently put to commercial use. The instrument consists of a stone cylinder coated with tin-foil, on which lies a metal band. One end of this band is connected with the mandolin sounding board, while the other end is attached to the receiving set by a coil spring. If electric current passes through the tin-foil, the metal band is attracted to it, even when the actual current is very small.

When used in connection with the radiotelephone receiver, the cylinder is kept revolving by a small motor. As the weak voice currents pass into the foil, the metal band is attracted or dragged along with



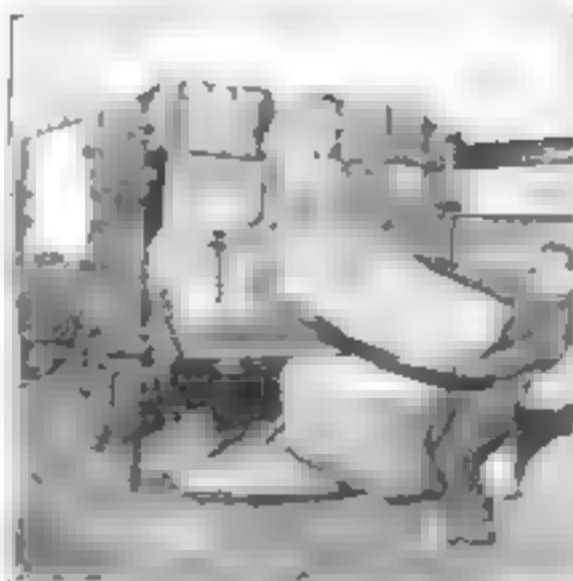
How electric impulses are transferred to mandolin sounding board



Receiving radio messages with the ingenious mandolin microphone type of loudspeaker

varying force as the cylinder turns, the impulses corresponding with the vibrations of the human voice. The band transmits these impulses to the sounding board of the mandolin, which amplifies them.

Truck Tailboard Is Freight Elevator



Let down to the "ground floor," the tailboard elevator is easily loaded



Up goes the load to the level of the truck floor or higher

TAILBOARD elevators that will hoist either the load or the truck itself have recently been invented by George Zaun, of San Bernardino, Calif. The chief purpose of the invention is to enable one man to load heavy merchandise quickly and easily.

Power is derived from the truck engine by an additional gear in the transmission

The lifting capacity of the elevator varies from 1000 to 4000 pounds, according to size. If the truck runs into a mudhole, the elevator, let down to the ground, will act as a 16,000-pound jack. It will lift the rear wheels of a heavily loaded truck clear of the ground, so that planks can readily be put in place, and the truck extricated from the mire.

Miners Dig Asphalt from Hold of Steamer

MINING in a ship's hold is necessary when the cargo is crude asphalt.

The asphalt is dumped into the steamer's hold and before it has been there 48 hours it amalgamates into a solid mass and resumes the same appearance that it had before being mined from the asphalt lakes. At the end of the trip it must be dug from the ship's hold just as it was originally dug.

It is often found, too, that in transporting the crude asphalt over the tropical railroads to the docks, it runs together and has to be "mined" again from the railroad cars.



Gas from Charcoal and Water Runs Tractor



A TRACTOR that runs on charcoal and water instead of gasoline has been recently perfected in the Philippines, according to reports from Manila.

The gas producer attached to the tractor is a light apparatus consisting of a generator and a scrubber. The generator is so constructed that superheated steam mixed with a definite percentage of air is blown through a bed of wood charcoal burning at a temperature

of about 3000° F. This produces water gas. The scrubber cools the gas from the generator, and removes dust and impurities by passing it through a series of baffle plates moistened with water.

The machine is said by the inventors to have an hourly fuel consumption of less than a pound of charcoal per brake horsepower, so that the cost of fuel is practically negligible.

Self-Propelling Swing Needs No Pushing

EXERCISE and a good time are combined in a self-propelling children's swing invented by George Manakourke, of Minneapolis, Minn. Without pushing, a child can swing to the full height of the ropes. The seat is suspended from two ropes, and is provided with a pumping footrest. The hands rest in sliding grips.

By pulling the hands downward and pushing out with the feet, force is applied on one rope attached to the support slightly in advance of the other. The result is to transfer the push through the footrest to the seat, making the swing go higher and higher.

Water Softens Cast Iron

AFTER cast iron has been covered by salt water for a century or more, it is said to become soft enough to cut with a knife when first brought into the air. After a time it hardens again. Cast-iron cannons from the ship *Edgar* are reported to have been as soft as lead when they were raised after 193 years under water.

Disabled Planes Send "SOS" with Kite Antenna

NO MORE need United States navy seaplanes be classified on the "lost and found" list. Through a novel adaptation of kites to maintain radio communication facilities for disabled seaplanes, Commander Taylor and Lieut. C. D. Palmer, of the Air Station Radio Laboratory, Anacostia, D. C., have perfected a method by which a plane can call assistance even when it is at rest on land or water.

Kites somewhat like those that Benjamin Franklin flew more than a century ago have been used in the recent naval experiments as instruments for elevating antennae when seaplanes are disabled or resting on the water.

Seaplanes heretofore have used antennae consisting of 200 or 300 feet of special wire that trail behind the plane like the tail of a kite when the machine is in flight. Just before the plane lands, however, the wire antenna is coiled up and the communication system "goes dead." Some seaplanes have been equipped with "skid fin antennae" of special radio wires rigged on the upper deck of the seaplane. The trouble with these for emergency use has been that they are of value only for



From the disabled seaplane the kite is flown with antenna wire. The wind from the propeller drives the radio generator.

short range communication over distances of from 10 to 15 miles.

The new kite equipment is simple and

weighs only a few pounds. There are two kites—one seven feet high for use where breezes are light; the other six feet high employed under conditions of high wind. A reel of unusually light-weight antenna wire is used as the kite string on which-ever kite that is used.

The kite is elevated to a height of from 250 to 300 feet above the seaplane so that the antenna will unfurl and string out. The propeller of the plane is used to develop sufficient wind pressure to start the kite to the desired altitude, where it is anchored by means of the antenna wire.

A canvas screen is so rigged in the direct wind stream of the propeller—in the case of a disabled plane—that with the motor running slowly, the wind will propel a radio generator that develops full power for sending

Disabled aircraft, either of land or sea type, can fly the kite as a signal also to attract the attention of rescue ships. In the cases of small aerial expeditions, a seaplane equipped with the new kite radio could be used as the central communication station for the entire party, acting as the flagship of the air fleet.

"Jack-in-the-Box" Light Aids Traffic Cop

SAFETY traffic lights that are set in the center of the road, but that drop out of the way when a car runs over them—and then bob up again without damage either to the light or the car—are the latest invention to aid the traffic cop.

An electric light under a heavy glass dome set in rubber gaskets to prevent damage by water is covered by a cone shaped housing of cast steel with slots that permit the light to shine through. The whole installation is mounted on a sliding



Under the impact of a colliding auto wheel, the light sinks to the road level.

collar and held above the road level by a strong coiled spring.

If a car should accidentally strike the light, however, the spring yields and the light drops until it is level with the road. The light will sink under pressure applied either to the top or sides.



Hydrogen Bubbles Weigh Galvanized Coatings

BUBBLES of hydrogen take the place of pound weights in a new testing device that will weigh the amount of galvanizing metal deposited on a square foot of surface regardless of corrugations. By means of measuring the volume of hydrogen developed, buyers of galvanized products at last have a quick and easy way to determine whether manufacturers have adhered to specifications.

The weight is determined by collecting and measuring the hydrogen gas produced by the action of dilute hydrochloric acid upon a measured area of the galvanized coating.

A "ring" or container resembling an inverted water-glass, fitted with a three-way cock, is placed on the sample and sealed at the bottom with acid-resisting wax. The chemist then forces all the air from the gas measuring burette, the rubber tubing, and the ring, by lifting a leveling bottle high above the apparatus, and allowing water to fill the tubes.

Hydrochloric acid is then introduced into the ring. The hydrogen produced forces the water out of the system, and collects in the measuring burette.

Micrometer Depth Gage Has Ratchet Stop

BY THE addition of a ratchet stop a standard micrometer depth gage recently has been improved so that the measurement of the depth of holes, slots, shoulders, and projections can be made with accuracy. The ratchet provides the gage with a delicate mechanical sense of



How the new micrometer gage measures the depth of a cut.

touch; the pressure of the measuring rod against the surface being measured is always precisely the same. The stop is operated by a ring at the top of the thimble.

The spindle is graduated to read in thousandths of an inch for one inch, and three hardened measuring rods give the instrument a range up to three inches.

As a special service to readers, the Editor will be glad to supply names and addresses of manufacturers of devices mentioned in this issue.

Why Your Shoes Wear Out

Self-Made Chemist, Probing Secrets of Leather, Creates Magic "Neutral Fluid"

By J. Olin Howe

DELVING deep into unexplored fastnesses of nature, beyond the range of powerful microscopes, Fred Howard, known as "the people's chemist," of South Easton, Mass., has discovered a secret that for centuries chemists have sought in vain—a magic neutral fluid, devoid of chemical properties, which is opening up almost undreamed-of possibilities for revolutionizing the manufacture of goods that people need.

A Practical Scientist

Fred Howard is not merely a leather chemist and an explorer of nature's most minute mysteries. He believes in serving mankind through the practical application of each of his achievements. Even now, by his numerous discoveries, he is saving our shoe leather by increasing its life; he is protecting our clothes and fabrics from the ravages of moths and other insects; he is baffling the bacteria that cause mildew; saving rare old books and prints from decay; fireproofing textiles; preventing oxidation of silver; protecting iron from rust—and even purifying the air we breathe! Indeed, the power of his magic liquid, when applied to the improvement of every-day things of life, seems already to surpass the dreams of scientists who spent long years in search of its secret.

In producing his neutral fluid, Chemist Howard starts with an oil—any oil, animal, vegetable, or mineral—and finishes with a fluid that possesses no single attribute of oil. He breaks down the chemical structure, taking away, one by one, every quality that gave the oil its definite character. The neutral fluid that results is of colloidal character and spreads and penetrates almost beyond belief. It fairly acts at naught the law of gravity by running up the bare arm one thrusts into it. It makes its way among the fibers of leather, textile,

or paper with a truly surprising power of penetration.

By this almost uncanny substance the chemist redeems leathers spoiled in the



Cloth that Won't Burn

With his magic neutral fluid, Chemist Howard has been able to fireproof textiles, particularly those used in clothing for workmen

tanning, stiffened by water, or burned and made brittle by the acids in perspiration. By waterproofing leather he makes shoes wear twice as long. He doubles the tensile strength of belting leather and makes it impervious to acids as well as water. Cordovan leather becomes soft and pliable by his process and is rid of the objectionable "bloom" that comes from the stuffing chemicals. One Massachusetts shoe manufacturer says he saves \$500 a day by the use of a single Howard formula. In another case \$25,000 worth of beel lifts were apparently ruined during a flood. Howard not only restored them to full usefulness, but increased their worth to \$32,000 on a rising market.

The "people's chemist," who is also the "trouble man" of the leather industry, became a chemist as the result of his interest, while a youth, in the composition of the water of a famous spring on his grandfather's farm, which the future self-made scientist was exploiting in a thriving beverage trade. He hired a chemist to come to South Easton and teach him, and later he studied and worked with Prof. Alexander Bernstein in Boston. Then he hung out the shingle of the leather chemist in Brockton, Mass.

Why Tanning Coarsened the Leather

A shoe-manufacturer's uncle had asked him to find why hemlock leather, more durable than oak-tanned leather, often came from the tanning process hard and brittle and all but unworkable. After a year or more of hard work Howard had



Here, in his laboratory, Fred Howard has revolutionized scientific knowledge of leather fibers and made possible more durable shoes. By the use of chemical agents and microscopes he has found that what the tanner thought was a solid fiber is, in fact, a bundle of fibers or "filamites" infinitesimally small

the answer, but not the remedy.

Skins and hides are tanned to preserve them in flexible, usable condition. First, all grease, oil, and other matter must be cleaned from their fibers, and then tannic acid, found in hemlock or oak bark, is introduced. Microscopic studies of hemlock leather revealed to Howard that the resin of hemlock extract had been very unevenly distributed among the fibers and had thus matted and clogged them, thoroughly disturbing nature's exquisite weaving. Tannin crystals lodged among the fibers, and their sharp edges cut and split the delicate

strands drawn tautly across them.

Howard's task was to break up these crystals, redistribute the tannin, and, if possible, secure greater penetration. Eventually he accomplished all of this and more through a painstaking study of oils and the subsequent discovery of a liquid capable of carrying chemical agents to break up thousands of crystals in a single piece of leather.

Howard Reaches His Goal

When he began extracting from oils their undesirable qualities, he was on the way toward his goal. The outcome of his untiring research was a neutral fluid—which was not an oil, had no odor, was not greasy, did not attract dust and could make his way between the molecules almost unbelievably—and Howard had his carrier.

In connection with these experiments Howard revolutionized scientific knowledge of fibers. Previously the accepted theory had been that fibers, those delicate filaments with which nature does weaving quite beyond human power, were solid. Howard found the reverse to be true. He discovered that every fiber is but a braiding of lesser fibers which he termed "filamites." Each small filamite in turn is but a bundle of lesser filamites, and so on.

By the use of chemical agents he has actually divided and subdivided fibers until he has gone beyond the limits of the human senses, finally reducing a filamite to something so small that it passes outside finite limitations.

Howard's discoveries in chemistry include more than 1000 new formulas.



These two pieces of leather, cut from the same hide, were allowed to hang in a storeroom for 15 years. At the end of that period the piece at the right, which had been treated by the chemist's formula, was pliable enough to be used in a new pair of shoes. The untreated piece cracked and broke when bent.

Guatemala Reproduced in an Acre of Concrete

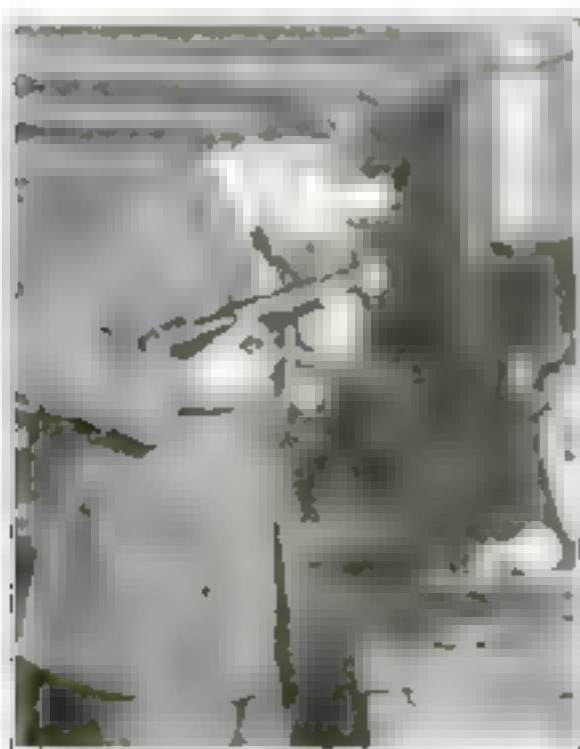


EVERY Guatemalan hill and peak, every pulic park, stream and riverbed, have been reproduced in solid concrete in Guatemala, the capital city of the republic. A large enclosure is covered by what is said to be the only re-

map of an entire country. It represents 15,000 square miles of soil.

The needlelike peaks of the Sierra Madre, which runs through Guatemala are all present in correct proportions, with lines to indicate every thousand meters of

elevation. The contours of the rivers have been accurately laid out in the concrete, and at the turn of a faucet the streams with their falls and cascades spring into action. An elevated promenade encircles the miniature country.

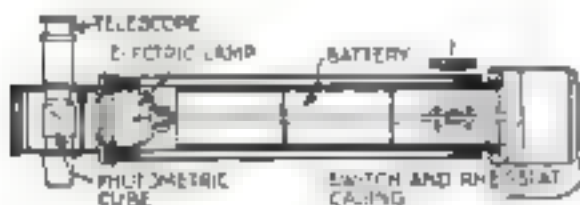


New Light Meter Measures Brightness Accurately

WHETHER you have sufficient light to do your work properly can now be determined in a second with a new light-measuring device that reads directly in candlepower.

A sheet of white paper is placed on your desk or workbench. As you look at the paper through a small telescope, you see a double image in the instrument. When you slide the large tube of the telescope back and forth until both images have the same brightness, the degree of illumination and the glare upon your desk can be read on a scale.

Inside the instrument is a small dry cell that lights a standard electric bulb. The



Construction of the light meter is shown in the above diagram.

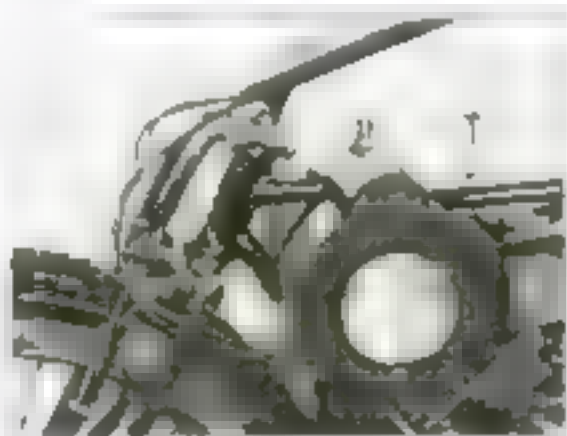
Light from the test paper comes directly to your eye, while the rays from the standard lamp are reflected through a glass cube at right angles, so that you see two ellipses, one of which shows the light from the lamp, the other from the test sheet.

Moving the large tubes alters the distance between the lamp and vision.

Water Cooling System Is Applied to Motorcycle

A MOTORCYCLE with a water-cooling system has recently made its appearance in Belgium. The radiator consists of a group of thin, circular metal rings placed astride the central frame just behind the handle bars.

Water enters at the top of the radiator and flows in a thin sheet down the sides of the disks. A comparatively large cooling surface is thus brought into play. Increased power and mileage are claimed for the machine.



The radiator, behind the handle bars, consists of thin metal disks.



Semicircular Toothbrush Cuts Dentist Bills

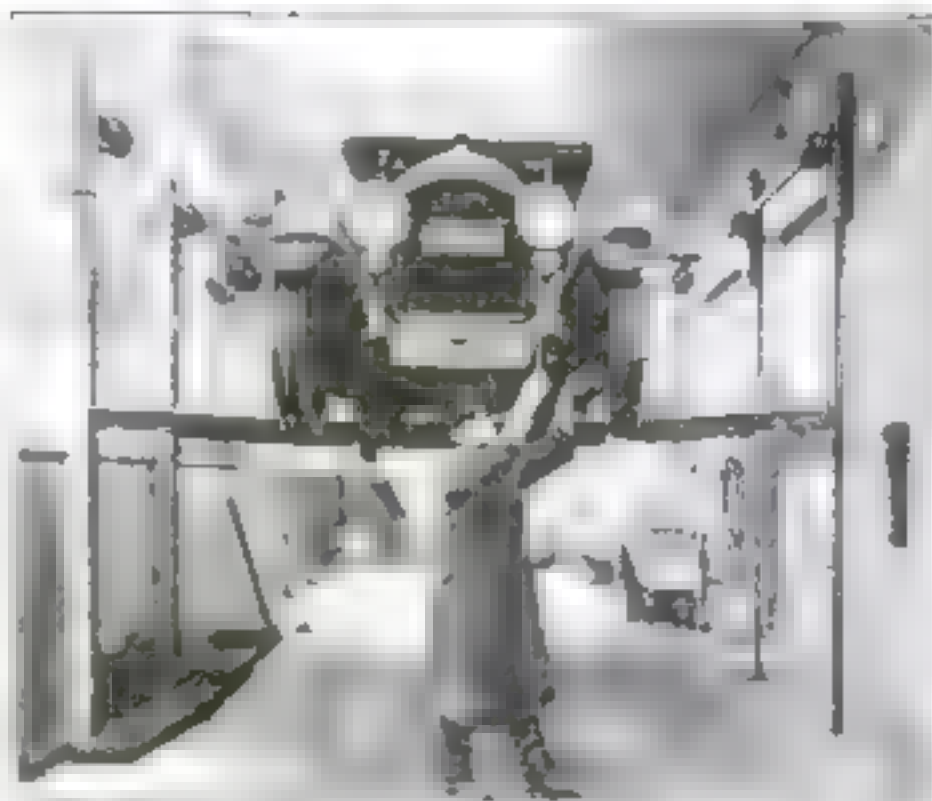
A NEW toothbrush, the bristles of which are arranged in semicircular form, makes it easy to brush your teeth according to the dentist's instructions.

The curved form cleans the front and back of the teeth simultaneously, and makes it natural to rock the brush back and forth, so as to reach the crevices between the teeth where infection starts.

Simple Hoist for Automobiles Aids in Repairs

GARAGE hoists that will lift an auto to any height desired, expedite repairs in an Oakland, Calif., shop. The apparatus consists of a steel dolly that fits under the chassis, with projecting steel beams that rest upon a framework of I beams raised by a specially designed elevating gear.

Power is derived from an electric motor so that the hoisting can be controlled from the rheostat. A worm gear acts as a safety brake. After the car is lifted to the right height, a ratchet is set to hold the hoist firmly in place.



Driven by an electric motor, a steel platform under the chassis lifts the automobile to any desired height.

Offset Speeds News Photos

CLEAR newspaper photogravures of Saturday afternoon events may soon be on American breakfast tables Sunday morning as the result of a new offset printing process recently invented by William Glass, of New York City. By this process photogravure newspaper supplements can now be printed on coarse newspaper print paper by the offset newspaper printing presses. Even a small newspaper can publish an illustrated supplement on its offset presses within seven hours from the time copy is placed in the engraver's hands. In one case a four-page supplement was rushed out in 45 minutes.

Combination of Processes

Heretofore this work has been done by special presses and special paper, and 24 hours of preparation has been considered speedy work. The saving of time is accomplished by more rapid engraving and the elimination of "make-ready."

The new offset method is a patented combination of processes developed from photo-engraving, lithography, and rotogravure. On the presses, the paper never touches the type, but passes between two rubber rolls that rub against the type cylinders, sucking off the ink and transferring it to the paper. This makes it possible to print both sides of a sheet of paper at once—a fundamental improvement in printing.

The printing plate, instead of being a heavy cylinder of lead, is a flexible zinc sheet, only .012 inch thick. The pictures and text are printed on the plate in a photographic manner, and then given a slight etching with acid. The result is that the parts of the plate that carry the ink are below the surface of the plate, so that the

Gliding between two rubber cylinders that take the impression from plate cylinder, the paper is printed on both sides simultaneously as shown below



The "offset" plate is a light, inexpensive sheet of zinc, only .012 of an inch thick and easily curved around and fastened on the press cylinder, as shown at the right



wear on the cylinders is carried by a broad surface. The plate will turn out perfect impressions until the surface is worn down nearly to the bottom of the etching. Thus one thin plate can be used for editions of more than 100,000 copies, which will make it popular with metropolitan newspapers.

The printing is lithographic, and depends upon the principle that oil and water will not mix. As the cylinder covered with the zinc plate revolves, it first passes under a dampening roll that wets the flat surface but leaves the etched design dry. Next it goes under a roller carrying a greasy ink,

which of course will not stick where the plate is wet, but clings only to the depressions where the design has been etched out. The offset rolls then borrow this ink and transfer it to the paper.

The lithographic method, as used successfully for color posters, could not be used for newspaper work until the new process was perfected, because the design was merely on the surface of the plate and soon wore off. In the new process it is etched into the plate, so that the tiny half-tone dots cannot be moved by the pressure of the paper or worn away.

Air Operates Cutting Wings of Improved Railroad Ditcher



This side view of the ditcher and spreader, with wings folded for transportation, shows the air cylinder for raising and lowering the wings



Plowing a ditch in a shallow railroad cut. Note the air-operated diagonal braces that sturdily support the outer end of the cutting wing

RECENT improvements in a standard ditcher and spreader for railroad use include air operated telescopic diagonal braces supporting the outer ends of the big cutting wings, giving the machine unusual flexibility in cutting to the standard cross section of any railroad. The outer edge of the cutting wing can be raised 39 inches above the level of the inner end. The grade at the bottom of the ditch formed is said to be just as true as at the top of the rail.

Mounted on a small flat-car and pushed by a locomotive, the machine acts on the principle of a snow plow. The ditcher is a curved plate of steel with a cutting edge that plows along the right-of-way, cutting out the form of the ditch and throwing the loosened earth to one side so that it will not return to the ditch.

A long steel extension acts as a spreader, moving the fill 20 feet or more from the tracks and distributing it evenly over the ground. The strength of these wings is

such, particularly with the new braces, that they can handle heavy loads of earth far out to one side without danger of bending the wings or buckling the braces.

It is claimed that speeds of from six to eight miles an hour have been attained while performing this work. In other words, one machine with a single operator will remove more than 75,000 cubic yards of earth a day. To excavate this by hand is said to require an army of 2500 men working for 10 hours.

Can You Play Your Profile on the Piano?

*Every Beautiful Face Has a Counterpart in Waves of Harmony
Says Scientist Who Analyzes and Photographs Sound*

EVERY beautiful human face translated into its own distinctive chord of music; every ugly face has its counterpart in a discord.

The scientist, in the rôle of musician, has now discovered a method of interpreting the soft, composite curve of a pleasing profile in rich musical harmony—not in the imaginative manner of the artist, but by exact analysis and mathematical equations that convert lines that are pleasing to the eye into sounds that are pleasing to the ear.

Every Violin a Stradivarius

In other words, he has made it possible, by cleverly designed instruments and methods, for you to play your profile on the piano! And, strange to say, he is using these methods with astonishing results, to perfect the tone and quality of musical instruments—to make every violin as mellow as a Stradivarius.

The scientist responsible for these discoveries is Prof. Dayton C. Miller, of the Case School of Applied Science, Cleveland, Ohio, who is recognized as an authority on sounds.

His first step was to select the curve of a beautiful profile and translate it into its music counterpart—that is, to produce a sound wave of the exact shape of the profile



Plucked in the middle, a harp string vibrates as a whole and in halves. In sympathy a string half the length also vibrates. These secondary vibrations are "harmonic overtones."



of the profile correspond to the simple wave forms of the component parts of the chord and resemble in their beauty those produced by the French horn. "This symphony of faces," says Prof. Dayton C. Miller, "is singing a melody to the eye as sweet as the note of the French horn sounds to the ear."

to further experiments, and that is resulting finally in successful efforts to analyze and improve the tones of musical instruments.

For more than half a century, scientists have recognized the principle that beautiful sounds are complex blendings of separate, simple component sounds that may be detected by the trained musical ear.

If the original sounds are a composite of simple tones, it naturally follows that their wave shapes are a composite of simple wave forms. And it is possible, by the use of an ingenious differential calculus device, known as the "harmonic analyzer," to pick those complex wave forms to pieces and obtain finally the simple wave forms that go to make it up.

Discords Are Angular in Outline

Professor Miller's investigations show that all musical sounds are represented by composite curves that seem to flow smoothly with rounded bends and symmetrical groupings, creating an effect pleasing to the eye. The discordant musical sounds and noises, on the other hand, are always represented by waves that have kinks, sharp points, and zigzags. The richer a musical sound, the more complex it is and the more complex becomes the wave form; but it is always beautiful and smoothly flowing in outline.

In the profile experiment there was first produced a musical sound that corresponded to the curve of the profile. The wave form of this sound was then photographed, as complete evidence that the profile form had not been lost in the various transpositions. The method was as follows:

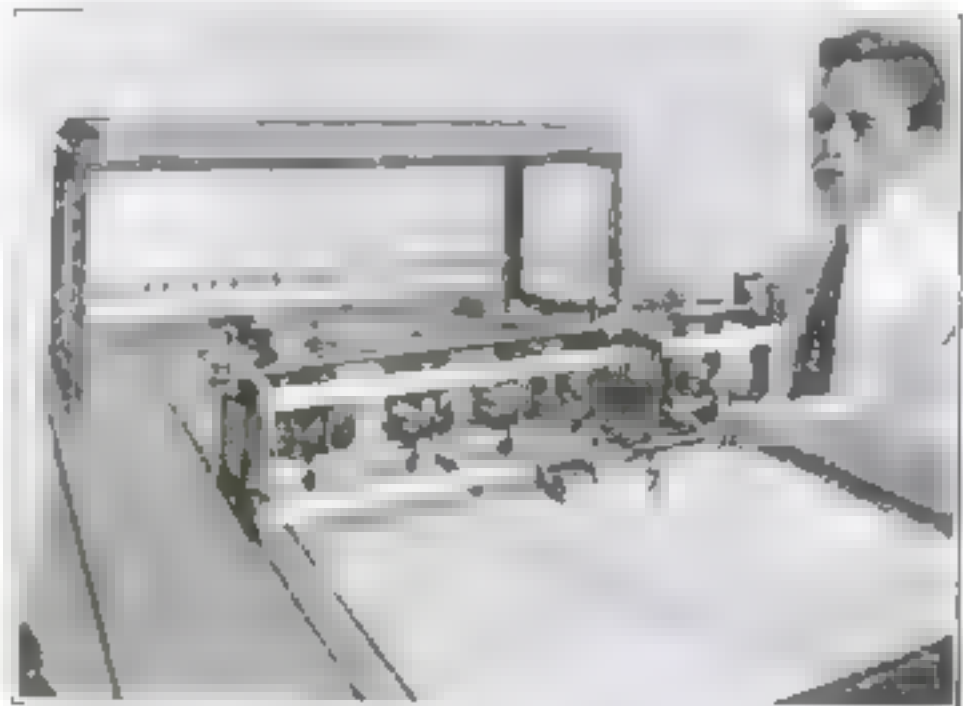
The profile of a famous movie actress was chosen because it represented what Professor Miller believed to be a perfect profile. A photograph of the actress was placed in a projecting lantern and thrown upon a sheet of paper. The profile was accurately traced. Then, by means of the harmonic analyzer, the profile curve was resolved into its simple component curves. There were found to be seven components.

and determine whether the ear interpreted this sound as beautiful. To perform this experiment Professor Miller devised a means of photographing sound waves, using a sensitive instrument, called a "phonodeik," of his own invention. This instrument consists of a diaphragm vibrating in unison with sound waves in the air and a mirror hitched to the middle of the diaphragm by a thread.

Sound Waves Pictured by Curved Lines

A bright beam of light is focused on the mirror and reflected to a moving photographic film. When a sound wave strikes the diaphragm, the mirror oscillates and the beam of light is waved back and forth across the film, moving at right angles. Thus on the film is recorded a curved line that corresponds in shape to the sound waves that vibrate the diaphragm.

Before he began his experiments, Professor Miller had noted that the richest and most beautiful sound he had ever heard was the middle register (contralto tone) of the French horn. Imagine his delight when the photograph of this sound form resembled a woman's profile of decided beauty! It was this discovery that led



Prof. Dayton C. Miller at work on his "harmonic synthesizer," which draws out all the harmonics of a sound wave and then can add them up and redraw the original wave.

Then seven organ pipes were selected, each of which was known to give a sound with a simple curve corresponding to one of the simple component curves of the profile. All of these pipes were connected with a source of compressed air and sounded simultaneously. The result was a rich harmonious chord, with a sound very like that of the French horn that had suggested the experiment!

Then, to check up the result, the organ pipes were set up before the phonodeik and sounded while a photograph was made of the sound wave form. The result was a series of wave forms exactly corresponding to the original profile.

Overtones Proclaim Quality

The same instruments and methods are being used by Professor Miller in his interesting attempts to place the making of violins and other musical instruments on a scientific basis—in other words, to assure beauty of tone in each instrument. For example, he is now studying the tones of the violin to find out just what sort of material and design produce sweet tones in one instrument and what produces cat howling in another. He is discovering the effects of material, design, and workmanship by means of the phonodeik, which photographs sound waves, the "harmonic analyzer," which breaks them into their component parts, and a "harmonic synthesizer," which puts them together again.

According to Professor Miller, who bears out the theory of Helmholtz, the tone quality of any musical note depends upon its overtones—if they are many and strong, the tone is rich; if they are few, it is not. True harmonic overtones always have wave frequencies that are multiples of the frequency of the fundamental tone. Thus the first overtone of middle C is C an octave above, for the simplest multiple of one is two, two is twice one, and doubling the frequency will obviously raise the pitch one octave.

A tuning fork has no overtones, and therefore its record on the phonodeik is a simple, smooth sine curve. A flute gives a more complex curve. Various instruments give various curves. The curves of the bell and piano are very complex. The more overtones, the more complex the curve and the richer the tone. Some piano notes have as many as 42 overtones.

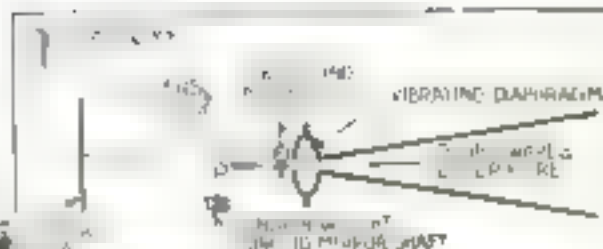
Professor Miller takes the sound wave photographed by the phonodeik, enlarges it, and analyzes it by means of the harmonic analyzer.

This gives a mathematical formula for each of the overtones. This formula is set up on the "harmonic synthesizer"—a machine that draws the simple tuning-forklike curve for the fundamental and each overtone, then adds up all of the curves and redraws the original curve. The result is the complete analysis.

Then Professor Miller selects a number of organ pipes each tuned to one component of the analyzed wave and corresponding in loudness or amplitude, and combines them over an air reservoir.

When sounded all at once, these pipes reproduce the original

The diagram shows how sound waves are photographed. The sound striking a diaphragm, causes a mirror to oscillate moving a reflected light beam across a photographic film.



Photographing sound waves from a flute by means of the "phonodeik" in Professor Miller's laboratory at Cleveland, Ohio. The sensitive instrument is mounted on a brick foundation to avoid vibrations from the building.

instrument note under analysis with a startling fidelity.

When visited in his laboratory, Professor Miller was operating a foot bellows under a queer looking set of pipes. He opened a valve. "A-a-a-a-a-a" intoned the pipes, sounding exactly like the human voice. Then a couple of times he pinched a rubber hose that supplied the air. "Papa" said the machine very distinctly.

A tiny set of pipes said "papa" in the wavery treble of a baby's voice, and nine other sets produced nine other vowel sounds exactly as if real persons had intoned them.

"These are close imitations because they exactly reproduce all of the components of the sound of

the human voice," said Professor Miller. Synthesis of actual sounds in this fashion proves our theory correct."

The effects on tone quality caused by differences in construction of musical instruments is shown by the analysis of the sound waves of two flutes, one a silver concert flute with a small bore, designed for playing very high notes, and the other a silver bass flute. The tone of the concert flute is somewhat dull, although it is sweet. The bass flute, which has a large bore, on the other hand, has a full, rich tone.

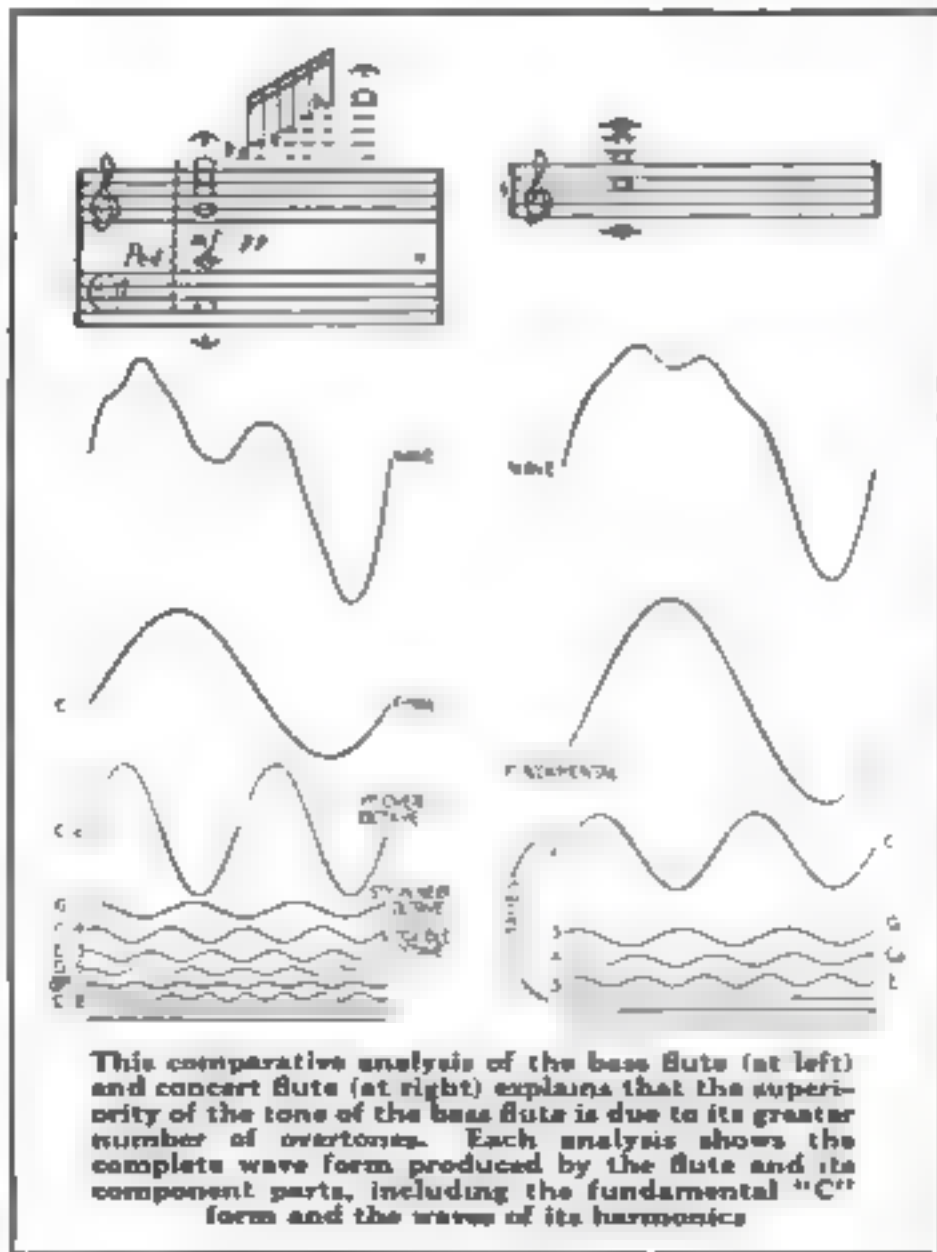
Secrets of Tone

The phonodeik record of the tones of the two instruments shows a family resemblance. The wave lines of both rise to a peak, dip down, rise again not quite so high, and then descend. Both tones are middle C.

The analysis of the concert flute reveals that it possesses only five components, most of them weak, while the bass flute has eight strong ones.

"The real beauty of a flute is not in the notes of piercing highness, such as the piccolo produces, but in the lower tones," says Dr. Miller. "The concert flute has been wrongly developed for the high notes, and therefore must have a small bore. It cannot develop full rich tones, for the small bore makes the overtones impossible."

Flutes of different materials show different overtones, even when they are of the same design. Glass, a hard, rigid material, produces almost no overtones, while gold, a soft material, produces very many. Such variations as these, which Professor Miller is studying in the violin,



will make or mar any kind of musical instrument.

A case in point is the oboe. Analysis shows that it has 20 components, and the upper overtones are very loud, producing the acid "bite" that is characteristic of this instrument. A pipe imitation of an oboe, taken from a typical pipe organ, has a similar sound, but is not an exact duplicate. An analysis reveals the reason. The organ pipe develops only 11 overtones, compared with 19 developed by the real oboe.

Organ as Orchestra

Using the phonodisk, it is possible to build organ pipes that are such accurate imitations of orchestral instruments that the difference can hardly be detected. One pipe-organ builder is making what he calls an "orchestrator" which so exactly imitates a great symphony or-



These four sets of scientifically combined organ pipes say "a-a-a-a" or "papa" in bass, tenor, alto, and child's voices. Note that the number of pipes increases with the complexity of tone, the bass voice requiring the greatest number.

chestra that even an experienced musician is deceived.

The irregular wave of the clarinet gives prophecy of many overtones. The analysis of a clarinet wave shows a general, family resemblance to the oboe.

The wave from the bell shows extreme irregularity. Moreover, the wave does not repeat itself, but changes constantly. This extreme irregularity shows why it is so hard to determine the pitch of a bell. Harmonics are so very strong they almost obliterate the fundamental tone.

Musical Optimism

"It is not too much to expect that the wonderful tones of a Stradivarius may be exactly duplicated in any number of violins," Professor Miller says. "It is not beyond dreams that all musical instruments may be greatly enriched in their tone qualities."

Membrane from Ox to Make New Dirigible Safe



Strip of goldbeater's skin ready to be cemented inside the gasbag.

IN A workroom as clean as a hospital, at Akron, Ohio, 300 women and girls are carefully cementing a fabric of goldbeater's skin inside the gasbags of America's third giant dirigible, the ZR-1, modeled after the ill-fated ZR-2.

As one of the steps in correcting errors in design that caused the disaster to the ZR-2 at Hull, England, the skin is being adopted to insure that the 18 large balloonettes to be used as gas containers in the ZR-1 will be absolutely leak proof. A layer of goldbeater's skin cemented inside the fabric of the containers will prevent air from seeping through to combine with hydrogen into an explosive mixture.

Goldbeater's skin comes from the large intestines of cattle. Each ox furnishes a strip only eight inches wide by 30 inches long. The size of the new ZR-1 may be realized from the fact that more than 600,000 oxen will be needed.

The skins are carefully scraped and cleaned, packed in glycerine to keep them flexible, then are sent to the cementing room where the fabric is stretched.

After coating the cloth with rubber cement the girls spread out the goldbeater's skin, trim each strip into shape, and roll it down tightly, overlapping each strip. The

surface is next varnished with more rubber cement, the cloth sewn into great bags, and the seams coated with more skin. The completed bag is thus rendered impervious to hydrogen.

Every worker wears felt shoes, and the floor, carpeted with canvas, is swept constantly with a vacuum cleaner to remove any dust and dirt that might collect under the skin. The sheets of skin are so thin that sharp particles working through might make thousands of tiny leaks.

The air in the room is under pressure, so that if a door is opened air blows out, instead of a dust laden draft blowing in. The air pumped into the room is filtered through dozens of sheets of woolly fabric.



Electric Iron Removes Old Paper from Wall

IRONING old paper off the wall, instead of laboriously scraping it away by hand is the function of an electric and steam wallpaper remover invented by A. W. Tucker, of Tulsa, Okla.

The instrument uses an electric heating coil to generate steam in a small boiler. The steam escapes through small pores in the flat surface of the tool, and forces its way through the paper to the sizing behind. The combined heat and moisture loosen the glue, and the paper is then easily removed with a scraper.

Seaplane Designed to Map Forests from the Air



The observer-photographer's seat in the fuselage, showing universally mounted camera.

A SEAPLANE specially designed for the aerial photographer by the Dayton-Wright Company, of Dayton, Ohio, is to be used in making an aerial map of Canadian forests over territory so difficult to traverse that mapmaking by the usual method of triangulation is impractical. Photographs of the forests will enable lumber companies to locate the best stands of timber.

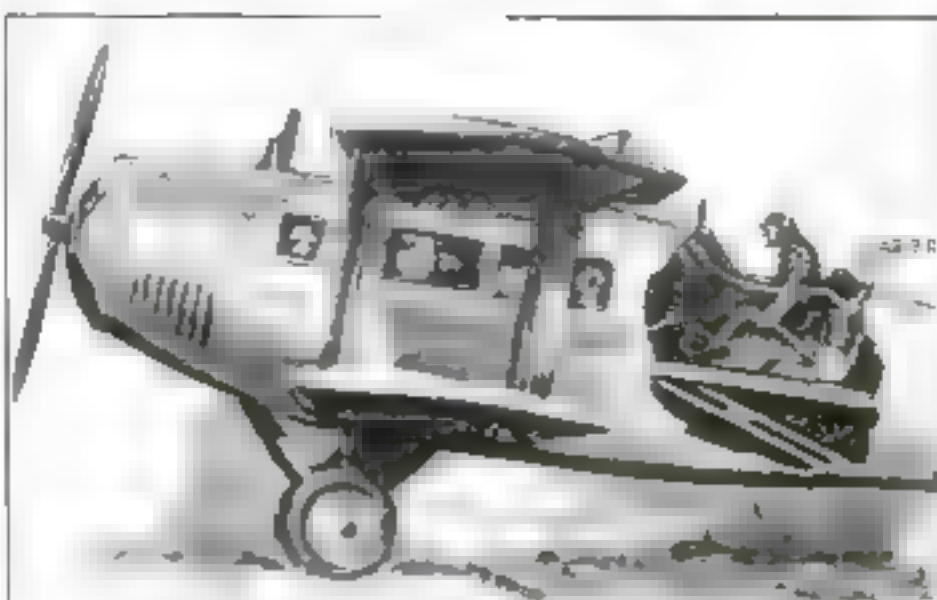
A seaplane was chosen for the work because of the many small lakes in the territory, and because there were no adequate landing-fields. To insure quick maneuvering on small ponds, the plane is mounted on floats instead of a boat hull. Two Liberty motors supply an excess of power to make the plane rise quickly.

To permit unobstructed vision on all sides, the observer-photographer's seat is placed well forward in an inclosed fuselage with windows on the front, sides, and bottom. The camera is universally mounted, so that the plate is level, no matter at what angle the plane may fly. The cabin is large enough to accommodate bunks, and the plane will carry sufficient food and fuel for long trips of exploration. The machine's range is 325 miles at 90 miles an hour. It is designed to provide every possible comfort for journeys over the forest wildernesses.

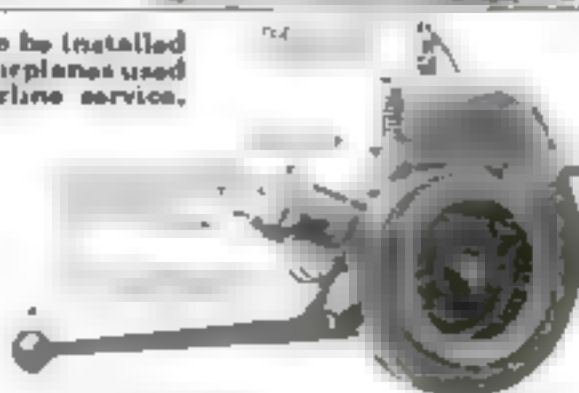
Airplane Pilot Can Now Start His Motor from Cockpit

A GASOLINE self-starter for airplane engines that weighs only 40 pounds and will start a cold 500-horsepower motor in 17 seconds has been designed in a form that can be mounted permanently in the fuselage and operated through a lever by the pilot in the cockpit. This, of course, does away with the very dangerous practice of starting a plane by swinging on the propeller, and enables a pilot to start a stalled motor without leaving his seat.

The starter consists of a small one-cylinder, two-cycle gas engine with three-inch bore and 2 1/4-inch stroke, coupled to a force pump of similar size. To start the motor the pilot pulls up a hand lever, and as the pump begins to operate, it draws an explosive mixture from the carburetor,



How the self-starter is to be installed in one of the passenger airplanes used in the London-Paris airline service. Arrangement of the power and pumping cylinders and the starting handle in the new self-starter is illustrated at the lower right



delivering the mixture under pressure to the main engine cylinders through small copper pipes. The gas is introduced through a distributor or timing device driven by gearing from the main engine. This distributor passes the compressed gas to each cylinder, first on the firing stroke, then on its induction stroke.

As a result, after one revolution of the main engine, the whole intake system is filled with a rich priming mixture, and when a short-circuit switch between the starter magneto and the main engine magneto is opened, the engine fires and picks up on its own carburetors. The quick pick-up is due to the fact that the starter supplies both gas and ignition.

The mixture enters the cylinders at 140 pounds pressure to the square inch.

Unreinforced Concrete Wins in Grueling Highway Tests

BY PACKING 10 years of heavy truck traffic into three months of actual operation on a test road and subjecting the road to a tonnage of 3,668,100 and a mileage of 96,000 engineers at the Pittsburg, Calif., test highway have discovered facts that are likely to revolutionize the construction of concrete highways through the country.

They learned, among other things, that much of the roadway built up of four and five inch concrete slabs will not last out the bond issue covering their construction. They also discovered that thick unreinforced slabs withstand the pounding and abrasion of heavy destructive traffic better than thinner slabs with steel reinforcement.

In planning for the tests, which were described in the February issue of POPULAR SCIENCE MONTHLY, engineers built 12 sections of roadway, each section having definite characteristics as to thickness of concrete and distribution of reinforcement. Over this roadway, beginning November ninth and continuing up to the first of the year, 40 trucks loaded at various

times with from 24,500 to 29,000 pounds gross weight traveled 96,000 miles.

Soon after the beginning of the test certain portions of the road began to disintegrate and later the destruction became so rapid as to cause the engineers much concern in their attempts to maintain the highway for the duration of the test period. When a pulverized spot was discovered, the concrete was cleaned away from it to a depth of 16 inches. A four-inch block of wood was placed at the base and over this a second block 12 inches high, bringing the top of the block even with the pavement.

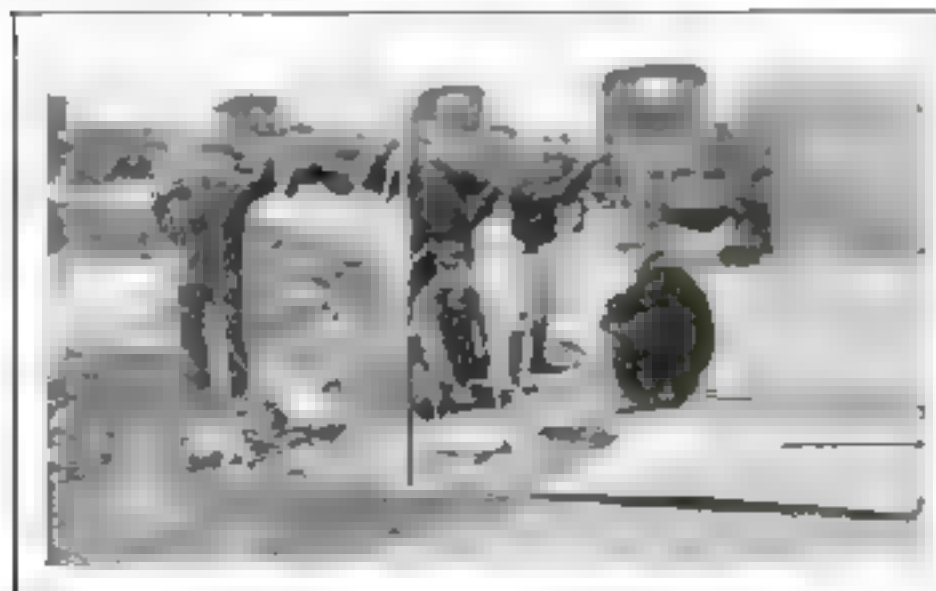
How Records Were Made

Accurate measurements of the movement of the concrete slabs from the start of the test to its finish were recorded by instruments installed in tunnels under the sections. The deflections of the road were transmitted to the tunnel by rods, the upper ends of which were embedded in the concrete. The records were made continu-

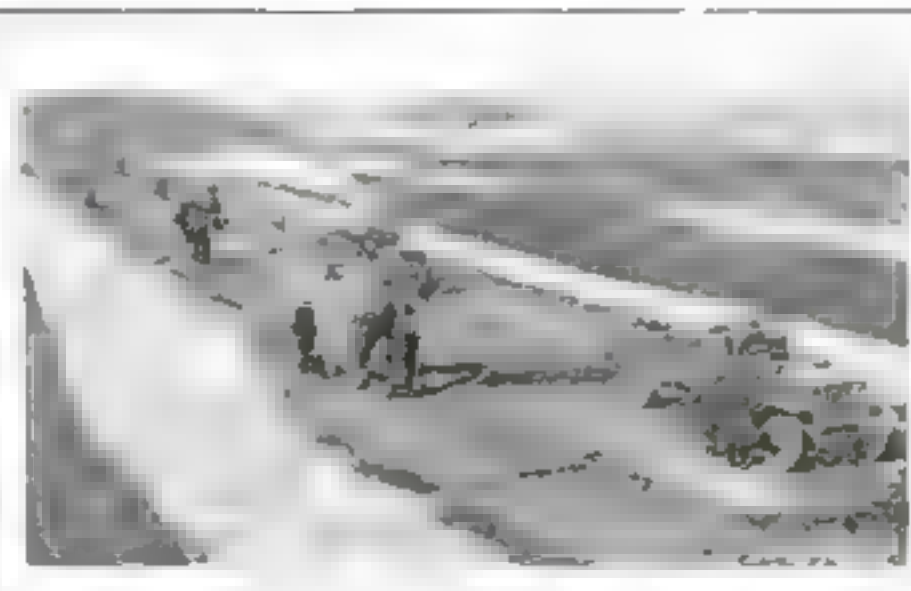
ous by means of a sheet of paper passing under the ruling pen of the gage.

Observation of the action of the pavement during various times of the day and under differing conditions of temperature and weather disclosed two distinct types of waves in the pavement surface. One of these appeared transverse of the slab with the edges cupping up at night and curving down in the daytime. The second wave was a "buckling" of the concrete surface that ultimately developed into cracks.

The tests have practically proved that any roadbed built up of concrete slabs should be at least six inches in thickness if no reinforcement is used. The cost of steel for reinforcing a mile of road is approximately equal to the cost of an extra inch of thickness in the slabs. Considering these facts from an economic viewpoint, engineers who studied the results of the tests are convinced that a thicker slab is to be preferred to a thinner reinforced slab for road construction where the traffic will be heavy and continuous.



Repairing the test highway where two sections of pavement meet. Ends of steel reinforcing were sawed off, broken concrete removed, and the subgrade excavated, to be replaced with wooden



Two sections of pavement after the ditches were flooded for subgrade tests. A bad break appears in the foreground. The group of men in the foreground stands at the entrance of one of the tunnels

Freight Cars Unloaded by Automatic Scoops



POWER scoops for unloading cement from freight cars have recently been adopted at the Marseilles, Ill., lock of the Illinois Waterway. A cable that runs from the scoop to a small electric winch used to supply power controls a clutch that makes operation automatic.

As long as the workman pulls backward, the clutch is thrown out—much like the ratchet of a window curtain.

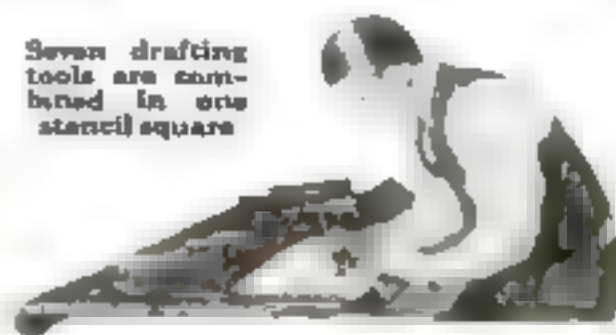
As he stops and plunges the scoop into the material, however, the clutch engages and draws the scoop to the door of the car. As it reaches the door sill, it stops automatically.

Snatchblocks on a wooden frame set in front of the car door give the proper lead. The device, shown diagrammatically in the insert above, can be used on any loose material, such as stone, sand, or coal.

Celluloid Stencil Replaces Drafting Tools

MUCH of the detail drudgery is eliminated from mechanical drawing by a new tool—a perforated square of transparent celluloid that acts as a stencil for

Seven drafting tools are combined in one stencil square



drawing fussy details, such as screw threads, nuts, bolts, lettering, fillets, and circles of the radii most commonly used. It is claimed that the instrument will replace seven drafting tools, and save over 80 per cent of the draftsman's time in making pencil sketches.

The square is approximately five inches over all, with a border cut in such a way that by its aid the draftsman can draw bolt- and nut-heads of various sizes. Conveniently placed holes for pin and pencil points facilitate drawing.

In the body of the device are punched the 15 commonest circles, which can be accurately centered upon the drawing.



The transparent square



Photos from Seven-Mile Height Are Accurate

FROM a height of seven miles, the largest aerial camera in the world will accurately photograph an object as small as an automobile passing along a road. To gain such a large magnification, there are three sets of lenses in the new camera, designed for the United States Army Air Service by Major Bagley.

With such a camera a battleship could be mapped by an airplane flying high enough to be out of reach even of the enemy's combat airplanes. At this height, small changes in the altitude do not introduce large errors into the scale of the map, as in the case with airplane pictures taken from low altitudes.

Greet Your Callers when You're "Not at Home"

A NEW pushbutton that makes it possible to leave a hospitable message to the friends who call while you are away from home consists of a little sign that flashes up when the button is pushed, saying, "Come again about — o'clock."

The new pushbutton appears to be an ordinary one, with your nameplate just above; but this nameplate is really a small cylinder that works like an annunciator. When you leave home you adjust the button by means of a circular dial. Then, whenever the bell is rung, the current operates a magnet that rotates the nameplate on its axis and exposes the message telling your visitor the hour at which you will be home. A circular dial adjusts the hour in the sign. The nameplate appears again as soon as the button is released.



The button registers the hour you hope to return



Luring the Lobster Is New Sport for Fishermen

A NGLING for lobsters with rod and reel is the latest sport of fishermen on the Pacific Coast. Heretofore lobster fishing, with traps and dip nets, has been about as thrilling as pulling an old boot out of water.

In the new pastime, no hooks are used, but the bait of raw liver is simply tied to the end of a casting line. When the angler feels a lobster nibble, he gently pulls the bait away in the direction of a net. After the first nibble the bait is kept resting on the sea bottom until the lobster catches up with it again. The moment the lobster begins to taste the bait again it is once more pulled away toward the net. Thus, little by little, the crustacean is coaxed over the rocky bottom until it is lured into the net.

Telescope, Mirror, Compass, All in One Instrument



A SMALL optical novelty recently perfected comprises two large converging lenses, two smaller diverging lenses, a mirror and a compass, all mounted in celluloid in such a way that all can be folded into a box seven eighths inch wide, $1\frac{1}{4}$ inch deep, $3\frac{1}{4}$ inches long.

When the device is opened, either of the large lenses may be used singly, giving about a six-inch focus, or the two may be



How lenses, mirror, and compass, mounted in celluloid, fold into box.

used together with a three-inch focus. One large and one small lens may be used together as a telescope, or both large and both small glasses may be used in combination as a low power field glass. When used as a telescope, the focus is adjusted by means of the telescoping handle.

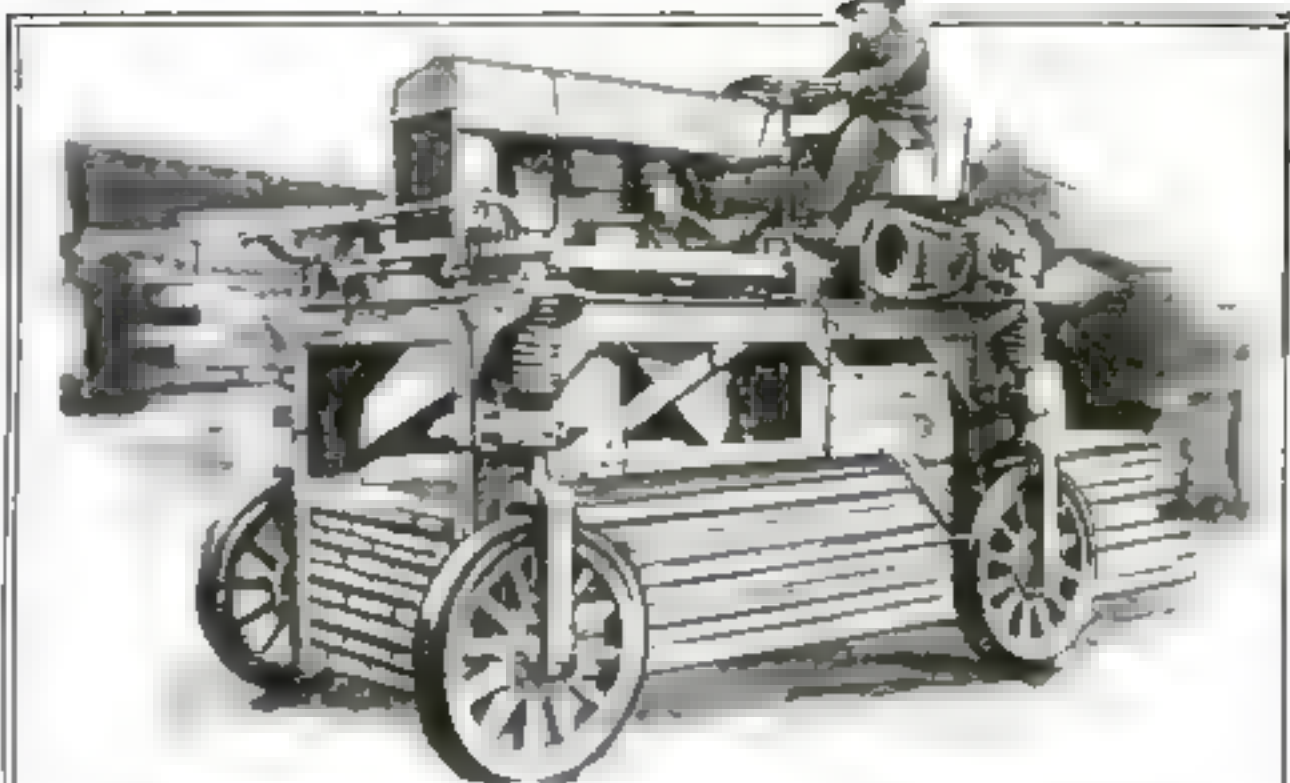
The pocket mirror finds a hundred uses and the compass occasionally comes in handy.

Huge Ice-Cream Freezer for Movie Stars

TO KEEP up with the ice-cream appetites of movie stars, an ingenious stage carpenter in a Los



Angeles studio built a monster freezer that will turn out nearly 100 quarts in one turning. The cream is frozen by an electric motor. The handle, as high as a person's head, is merely an ornament.



Tractor on Stilts Lifts Lumber Pile

A "TRACTOR on stilts" that loads itself with lumber by straddling a lumber pile and picking it up bodily with four claws, is said to have a surprisingly large capacity, in spite of the simplicity of its construction and low first cost.

Since the tractor is designed for use over the uneven ground usually found in lumber yards, no axles are used. Each wheel can move up and down independently, the vertical axle-mounting sliding against a coiled spring in a

bracket bolted to the steel framework.

To pick up a load of lumber the driver maneuvers his strange vehicle until it straddles the pile, which is mounted on a tray about four inches from the ground. Four claw-like members on the inside of the stilts then lift the pile. For power the engine of a well known light farm tractor is used, working through a double chain drive. A vertical chain supplies the power to the rear wheels. In unloading, the tractor simply drops the lumber from its claws.



Handy Twine Container on Belt Saves Steps

A CONTAINER for a ball of twine that can be fastened to the belt saves time in warehouses, eliminating the necessity of carrying packages to the wrapping bench, says Martin E. Gerould, of Rochester, N. Y., inventor of the device.

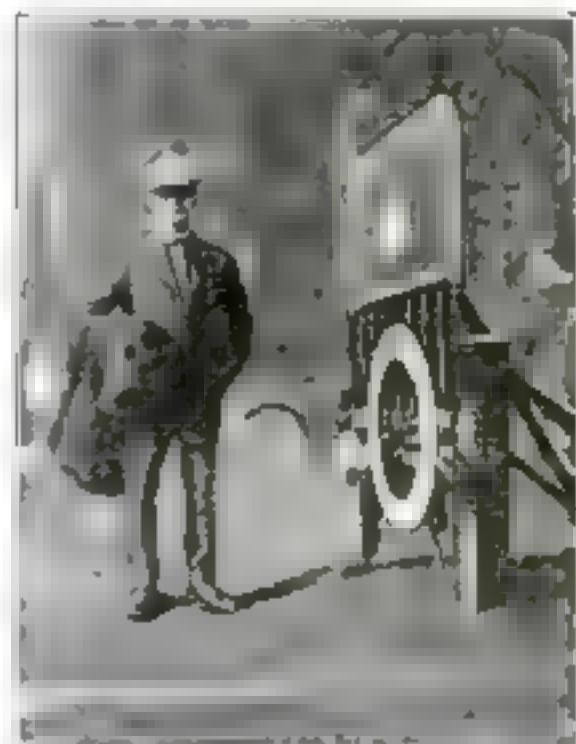
A projection from the belt clip, around which the loose end is wrapped, keeps the end within easy reach, and the cord always runs freely.

An increase in wrapping speed of about 25 per cent is claimed for this invention.

Dummy Auto Protects Trees in Parkway

TO PROTECT young trees growing along parkways, the Columbus Auto Club of Ohio has just installed a "keep off" sign that resembles the rear end of a car—tail light, tires, and all.

Reckless drivers had repeatedly knocked down other signs and damaged the trees badly; but the imitation auto now gives complete protection. The red tail light on the sign is lighted at night, and speeders naturally avoid it, fearing a collision.



Reckless drivers steer clear of this imitation, with its tire and tail light.

As a special service to readers, the Editor will be glad to supply names and addresses of manufacturers of devices mentioned in this issue.

Uncle Sam—Movie Producer

ONE ounce of farming film is worth a ton of agricultural pamphlets, say experts of the United States Department of Agriculture, who have made more than a million feet of moving-pictures to explain visually the whys and wherefores of modern agricultural machinery and farming methods.

The United States is the only nation in the world that maintains a complete moving-picture studio with trained directors and camera men. The only actors are the farmers themselves, who play the leading rôles. Wherever a man is noted for the efficiency of his methods, he is chosen to work before Uncle Sam's camera to teach the newest wrinkles to the rest of the nation's farmers.

Demand Exceeds Supply

Over 150 farming reels have been released in the past year, and more than a million rural families have learned how to reap more profits from the land by watching the movies. To any community that wishes to see a show, the government sends the films free of charge. So far the demand has been so far in excess of the supply that some states maintain special motor trucks, equipped with portable screens and projectors, which travel from one village to another with the subjects most in demand.

The most popular film is "Out of the Shadows," a story of the eradication of

When Uncle Sam's camera men go out "on location," farmers are the star actors and the plot is the "one best method of farming." A number of farmer-actors are shown at the right preparing for the camera



bovine tuberculosis from a typical dairy farm. "How to Select a Laying Hen," "Swiss Cheese Made in America," and "King Apple's Enemies" are constantly called for. "Exit Ascaris" is a film story about the economic losses caused by a parasite of young pigs.

Where Pictures Excel

The value of these practical movies lies in the quickness and clearness with which they explain complicated processes. For example, if the county agent wishes to explain how to build a concrete silo, 15 minutes of the film, "Construction of a Concrete Silo," will give his audience a better idea of the process than a day of explanation. The government is arranging to sell such films at

cost to farmers' organizations, with the proviso that admission to the exhibition of them shall be free.



Filming the explosion scene from the government thriller, "Construction of a Concrete Silo." The silo explosion in the miniature scene is produced by the man in the background blowing dust through a tube.

Revolving Harrow Saves the Orchard



These revolving harrows can be tipped up on edge and used as wagon wheels, as shown at the right.

THE tree scratching, weed catching spiny harrow of the farmer has been turned into a clutterproof implement that can be operated among the rows of a closely planted orchard.

By making the harrow in the form of a wheel and having the wheel in constant revolution, Hiram J. Wilcox has produced a tool that agriculturists have long desired.

The teeth of the harrow are attached at a sharp angle to the spokes of the rotating disk. This arrangement causes each of the 42 teeth on the five-foot wheel to describe a spiral path through



the top soil, reducing the caked earth to powder.

The circular form of the harrow permits it to pass around and between trees without tearing the bark. A unique axle mounting makes it possible for the harrows to be tipped up and used as wheels.

Small Trees Grow from Fallen Fir Trunk

SHAPED like an Irish harp, a fir tree growing from the side of a steep hill near Toggenburg, Switzerland, illustrates how nature adapts itself to adverse circumstances.

Through some accident the trunk was overthrown several years ago, and seemingly should have died. Instead, the trunk continued to grow, practically at right angles to the face of the cliff.

In following years branches grew and as they sought the sunlight they rose vertically from the practically horizontal trunk. As a result they are now in the position of small independent trees. It is interesting to notice that, although the arrangement of twigs on a branch is not ordinarily the same as that of branches on a trunk, the novel condition made twigs sprout exactly like branches from a tree trunk.



Branches grow like small trees from this horizontal trunk.

Why You Need a Summer Vacation

Physician Discovers Tests that Reveal Just How Your Work Tires You and What Sort of Rest You Require

By Wilfred S. Ogden

SCIENCE at last has discovered what physicians have long sought—a reliable method of measuring fatigue, and of determining your physical condition at any moment.

Using a system of tests recently perfected by Dr. C. Ward Crampton, of New York City, physicians can now tell accurately whether you are "run down," how badly you need a vacation, why you need it, and just how much of one you need.

These tests, which in a nutshell consist of measuring the resistance of your body to gravity's downward pull on your blood when you stand on your feet, are unfolding facts about the energy of brain and muscle and the effects of fatigue, that promise to become of tremendous importance to employers, educational experts, athletes, physical trainers—and in fact, to every person who is toiling with brain or hands.

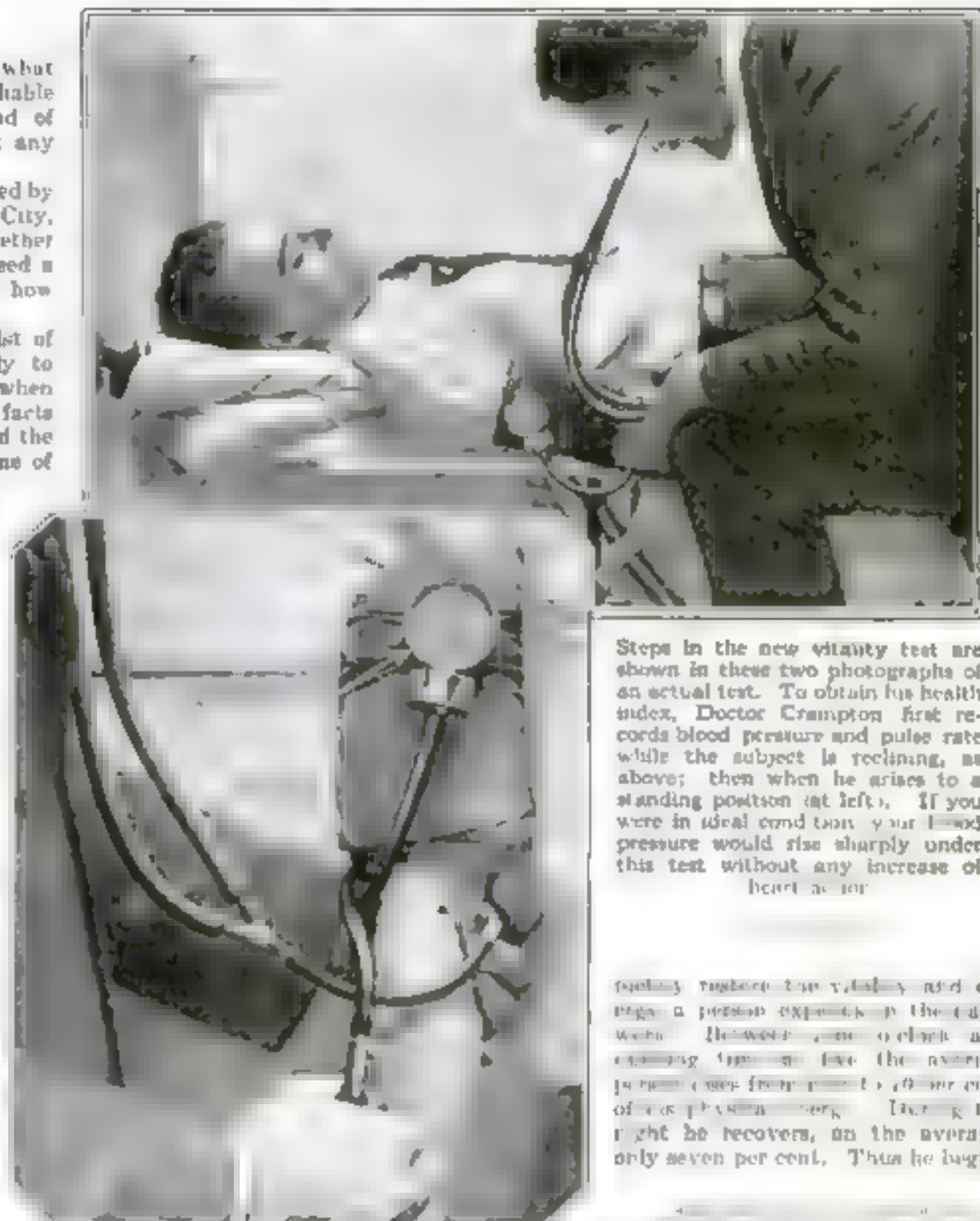
Athletes Who Will Win

Even now athletic coaches are using the tests with marked success before a game to pick the players who promise to give the best performance of speed, strength, and skill. The basketball coach can predict before the game starts just how accurately any one of his men will be able to "shoot" baskets. The baseball coach can tell which one of his pitchers is likely to allow the fewest hits and runs.

In discussing his tests, Doctor Crampton explains why it pays to laugh heartily, why night work and loss of sleep wear us down, why hot baths may lower our efficiency by relaxing the portion of the body into which blood drains from the brain, and why exercise of the abdominal muscles is necessary to keep us fit. His discovery opens up the secrets of success, pointing out the kind of work for which we are best fitted and the work that saps our vitality the least.

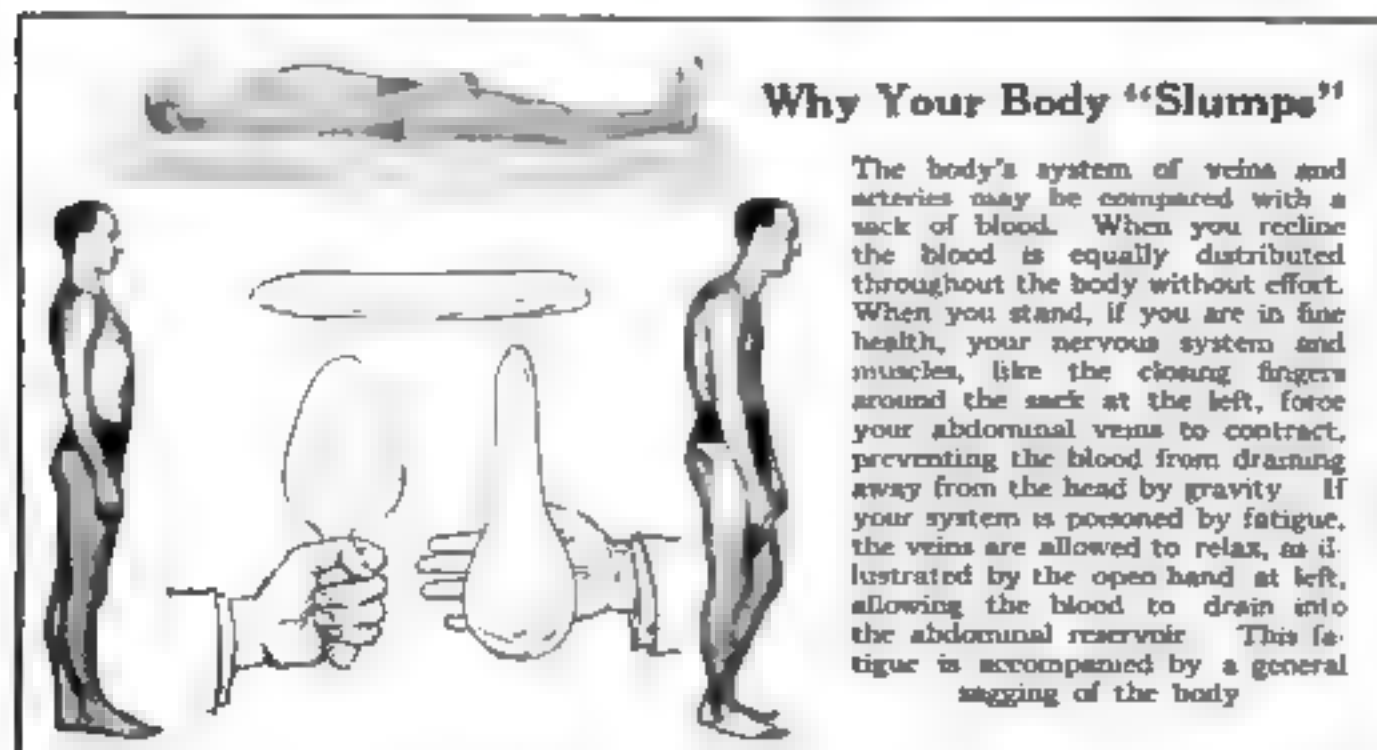
How important and necessary a vacation is in maintaining normal vitality is strikingly revealed by Doctor Crampton's actual

measurements of fatigue, which demonstrate that, contrary to the general belief, eight hours of sleep do not com-



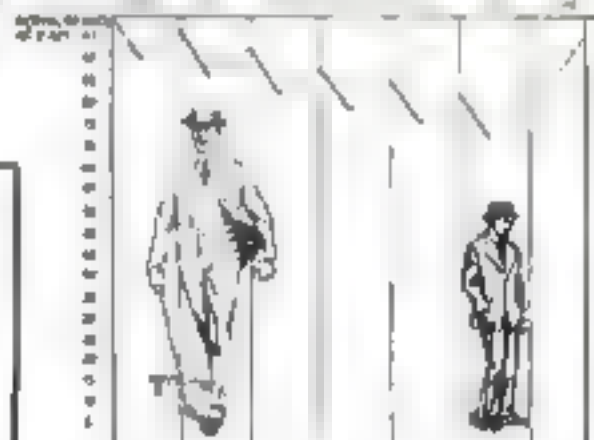
Steps in the new vitality test are shown in these two photographs of an actual test. To obtain his health index, Doctor Crampton first records blood pressure and pulse rate while the subject is reclining, as above; then when he arises to a standing position (at left). If you were in ideal condition your blood pressure would rise sharply under this test without any increase of heart action.

pletely restore the vitality and energy a person expends in the day's work. Between seven o'clock and coming through the average person loses from twenty to thirty per cent of his physical energy. During the night he recovers, on the average, only seven per cent. Thus he begins



Why Your Body "Slumps"

The body's system of veins and arteries may be compared with a sack of blood. When you recline the blood is equally distributed throughout the body without effort. When you stand, if you are in fine health, your nervous system and muscles, like the closing fingers around the sack at the left, force your abdominal veins to contract, preventing the blood from draining away from the head by gravity. If your system is poisoned by fatigue, the veins are allowed to relax, as illustrated by the open hand at left, allowing the blood to drain into the abdominal reservoir. This fatigue is accompanied by a general sagging of the body.

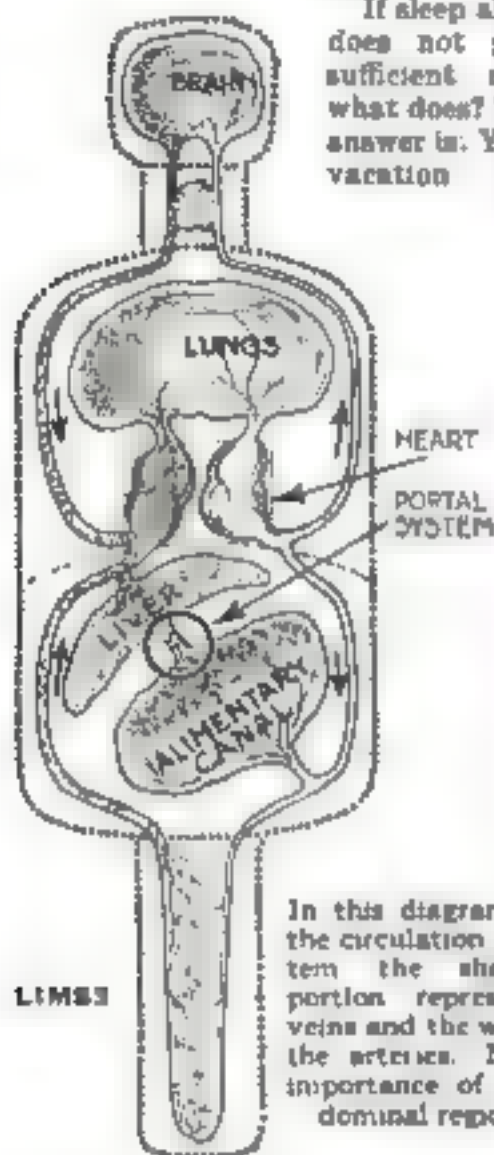


Why week-end recreation and a summer vacation are essential to avoid physical breakdown. Tests show that in each day's work the average man may expend from nine to ten per cent of his physical energy, while a night's sleep may restore only about seven per cent. Thus each day his vitality is two or three per cent lower than it was the day before. Note how much of this lost vitality is restored by recreation Saturday afternoon and Sunday.

the new day with an impaired vitality, two or three per cent below the point where he stood yesterday morning. As the week goes by, his vitality and force steadily drop, until he starts work on Saturday with far less energy than he possessed when he quit work on Monday night.

Obviously this cumulative fatigue, increasing from day to day in spite of what may be considered adequate rest, will soon result in a physical breakdown if allowed to continue unchecked. You cannot expend two per cent of your vitality every day, week after week, and stay on your feet.

If sleep alone does not give sufficient rest, what does? The answer is: Your vacation and



In this diagram of the circulation system the shaded portion represents veins and the white the arteries. Note importance of abdominal region.

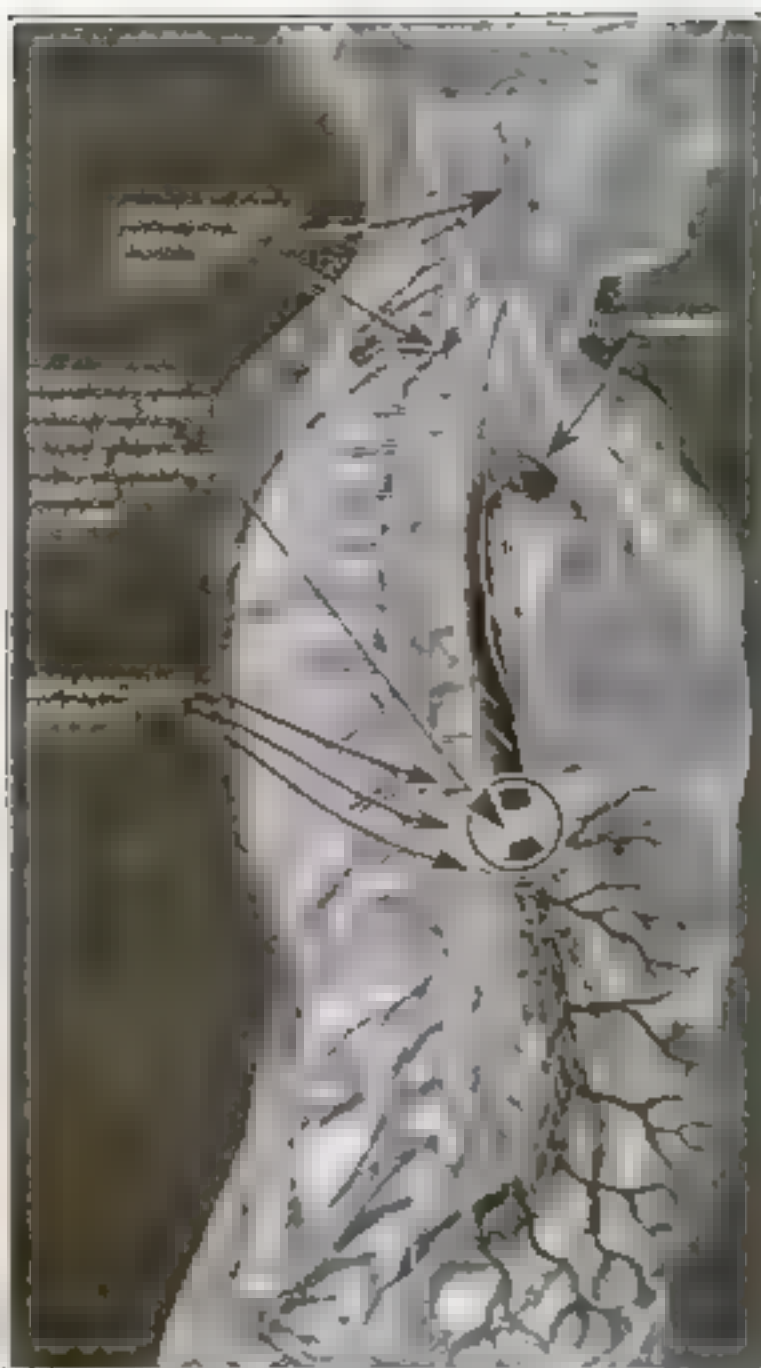
the recreation at the week end.

Fatigue depends upon so many factors of strength, such as pulse, height and weight, and the like, that, until Doctor Crampton worked out a table by which all these conflicting elements can be reduced to a common numerical value, physicians were unable to do more than guess at the actual condition of your health and vitality at any particular moment, or to determine accurately the effect of working overtime or staying up until three A. M.

Measuring Expended Energy

These facts Doctor Crampton determines by using blood pressure as a barometer of human energy. His method is to measure "blood ptosis," or downward displacement of blood. In non-technical language, he measures vitality by giving the body a certain fixed amount of work to do, and then measuring the amount of energy expended in performing it. The system might be compared with weight lifting. If you can lift a 50-pound weight with one finger, you are in excellent condition. If later in the day you need both hands to lift the same weight, it is evident your vitality has been reduced.

Irrespective of your weight and height, the work you do in rising from a prone to a standing position is constant. Its amount,



TO THE right and below the circle showing location of the portal vein is the "splanchnic mechanism," upon the working of which Doctor Crampton says "depends the blood pressure in the brain, on the maintenance of which, in turn, depends not only consciousness, but the working of every function of the body and even life itself."

The veins in this region, shown in black, will, if relaxed, hold almost all the blood of the body. Fibers from the splanchnic nerves, controlling the veins contraction, are shown in white.

Doctor Crampton has found, can be measured by taking the pulse rate and the blood pressure while you are lying down and again after you are standing, then comparing the two. In a vigorous man, the blood pressure should rise from eight to 10 millimeters of mercury as he rises to his feet. In a person exhausted by disease, overwork, or unhygienic living, the blood pressure may fail to rise, or even fall as much as 50 millimeters. The pulse rate acts in exactly the opposite fashion, increasing in proportion to weakness up to 45 beats a minute, but almost never falling. These two measurements mask each other to some extent, as a high heart rate may serve to raise blood pressure. Hence Doctor Crampton's table of measurements takes both factors into account. By comparing the two he records vitality in percentages.

The theory at the basis of this test is that the tone and vitality of the walls of veins and arteries reflect the vitality of the entire system. As you rise, hydrostatic pressure causes the blood to drain away from your head, but this tendency is checked by a constriction of the veins, particularly the large splanchnic or abdominal veins of the portal system, which act as the blood reservoir of the entire body.

If you are healthy these veins contract as you rise to a standing position and squeeze the blood back into the head, so that the blood pressure actually increases.

But if you are tired, long before any signs are visible, the contraction and tone in the walls of the veins are reduced. The poisons produced by fatigue have the effect of paralyzing centers in the sympathetic nervous system that controls the splanchnic veins, and a large amount of blood that should be in other parts of the body drains into these veins because of their relaxed state. Blood pressure falls, and the heart must beat more rapidly to prevent you from fainting whenever you stand up.

Posture Tells the Tale

This breaking down, under fatigue, of resistance to the pressure of gravity extends to the muscles and bones as well. A general drooping, slouching posture of the body, caused by downward displacement or depression of various bodily members, is almost certain evidence of low vitality. And this posture, in turn, tends to aggravate low vitality, thus establishing a vicious circle.

Downward displacement of the bones reveals itself in the drooping of the head, exaggeration of the normal curves of the spine, and the falling in and down of the chest. It is caused by weak tone and relaxation of the muscles that hold the body erect. In other words, it is the natural adjustment of the body to fatigue.

Relaxation of veins, and sagging of muscles, bones, organs, and spirits, all are related effects of a common cause—lowered vitality. As a rule, they occur together. Resulting from overwork, loss of sleep, or illness, "bad posture," Doctor Crampton declares, may be traced to "disharmonies" in the evolution of man through the ages.

"Evolution," he says, "has brought the body from a posture of locomotion on all fours with the trunk horizontal, up through gradual stages to the posture with the trunk erect. The body has not yet sufficiently adapted itself to the change. The head, instead of being on the long axis of the body, has rotated 90 degrees to this axis. It is kept erect by muscular force only, and tends to go forward and downward if muscles are weak."

What Is "Good Posture"?

"In the original horizontal position of the trunk, the internal organs hung from their attachments to the spinal column with sufficient room and with proper interrelationship. In the erect position, they hang from the side rather than from the top of the abdominal cavity. The intestines are heaped down in the bottom of the abdominal chamber. The contents of the chest rest upon the diaphragm, which in turn presses down upon the intestines. The abdominal wall tends to relax, allowing the whole body contents to sag down upon the pelvis and causing the abdomen to protrude. The best that can be done to relieve this condition is to keep the chest raised, to keep the intestines from crowding down by means of strengthening lower abdominal muscles and to conserve the nutrition of the nervous system."

"Anything that causes lower vitality, anything that works against health, or anything that works against happiness, increases the tendency toward bad posture. Bad posture is not so much a cause of low vitality as it is a sign or expression of past or present physical or mental depression."

The Crampton vitality test is made by placing a sphygmomanometer—a beltlike instrument for measuring tension of blood in an artery—around the upper arm, and inflating the band with an air-bulb until it is tight enough to stop the circulation in the artery of the arm. When the physician, with his stethoscope, can no longer hear the pulse beat, he notes the blood pressure. At the same time he has found the average pulse rate. The same test is repeated while the patient stands.

Secrets the Test Reveals

Applied successively to the same individual this test is extraordinarily accurate. It is employed by track coaches in determining which sprinters are in the best condition. It will reveal plainly the effect of losing an hour's sleep the night before; of smoking too many cigarettes, or of working in a poorly ventilated room. It has verified many theories about fatigue that physicians have long held.

For example, since a day's work destroys more than a night's rest can repair, it is obvious that every person should get as much sleep as possible. But does this mean it is always a mistake to go to a party and dance half the night? Should a man who wants to be healthy and work at the highest pitch of efficiency stay home seven nights a week?

Not necessarily. Play is almost as important as rest. The Crampton tests show that a feeling of pleasure counteracts fatigue. The effect of dancing and other violent exercises is a loss of energy, but the loss is not nearly so great as one might believe. Fatigue depends upon what you do, as well as upon how much of it you do.

One remarkable test was made upon an opera singer who was greatly fatigued by 10 minutes of easy typewriting. He was a man in excellent physical condition, yet in a few minutes he showed more fatigue than would a stenographer after eight hours of much harder work.

The singer was then asked to sing a long aria from an opera. He sang with full volume, acting out the part as if he were on the stage, and doing many times more work than he had performed at the typewriter. He strode from one end of the room to the

other, singing until beads of perspiration stood on his face, and winding up with a high C that shook the windows. Surely, a casual observer would say, his vitality index must have fallen after this vigorous



Which Way Is Better?

Doctor Crampton and other medical writers are convinced that the familiar posture of bending over a book, with legs crossed, which we often assume when studying, actually permits more intense mental effort than sitting erect, since it increases pressure on the splanchnic veins of the abdomen, thus maintaining a steady and ample blood supply in the brain.

exercise. On the contrary, it had not altered a particle.

Uncongenial work like typewriting tired this man, but singing, which he enjoyed, did not seem to tire him in the least.

Here may be found the scientific explanation of your success in the kind of work you like. You do not get tired. When you say "you could play baseball all day," you are merely overstating a scientific fact. We have all wondered why a kid brother is tired out when he is asked to rake the leaves from the front lawn, and then will go out with the gang and play football all the afternoon without complaining of fatigue. The new tests indicate that his naive explanation is really the truth—work tires him and play does not.

A hearty laugh is worth an hour's sleep. Every one knows that a

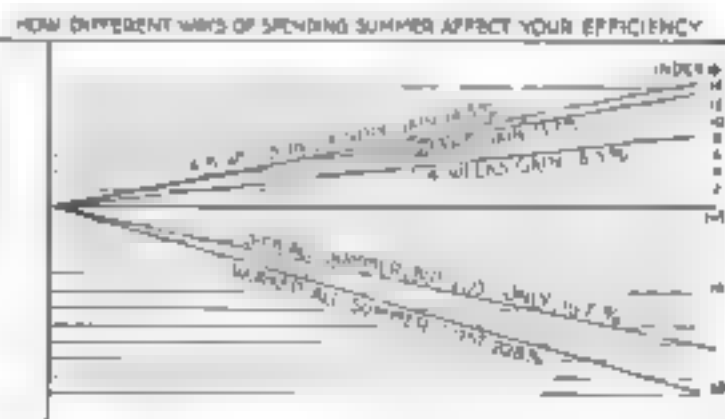
cheerful, good-natured person will do more work than the grouchy, and that a jolly man seldom appears to be tired. But not until the Crampton tests were applied was there a scientific explanation for this fact. Laughter stimulates the splanchnic veins. The rhythmical contraction and relaxation of the diaphragm during a hearty laugh stimulate the liver and the abdominal veins by a natural massage. The resultant improvement in tone of the vascular system is reflected throughout the body. You feel better and, as the Crampton test shows, your vitality has risen. Strangely enough, setting-up exercises that stimulate the abdominal walls act in the same way as laughter, although they do not afford the mental relaxation that is as important in relieving fatigue as physical rest.

Everybody Must Rest

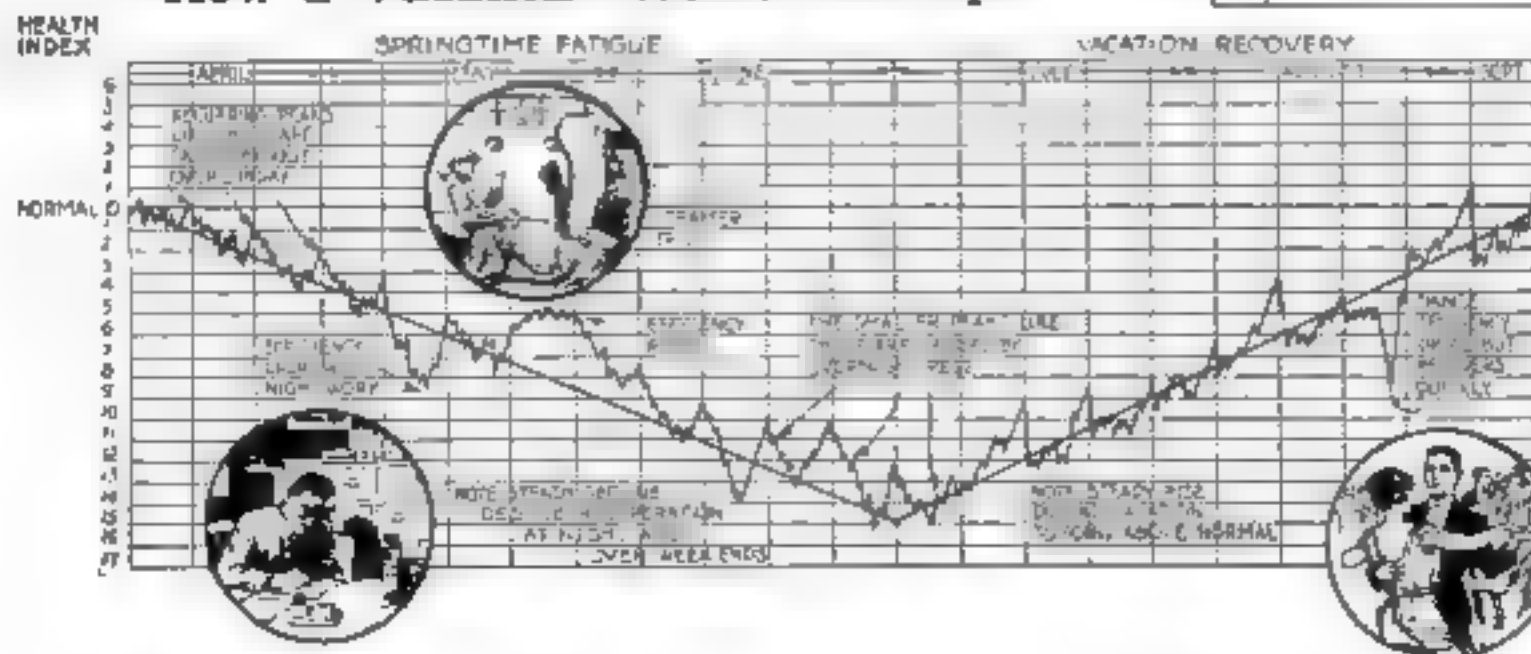
Although these newly discovered medical facts need not change the manner in which you rest, they do seem to prove that no person is strong enough to work steadily and constantly, without a Sunday off each week, or an annual vacation. In tests made on teachers in New York City, a group who worked all summer lost more vitality than those ill during the entire vacation.

The average loss of vitality after a week's work is about nine per cent of the Monday morning level, and may be as much as 20 per cent in the most exhausting occupations. Fortunately, the rate of recuperation depends upon the degree of fatigue, and the tests reveal that most people nearly make up the week's loss over Sunday. Individual records show great variation. One Sunday in the open air may make you gain 20 per cent. On the next you may lose almost as much. Opportunities for recreation vary, and so does the fatigue after a week's work, but on the whole the balance is steadily against you.

The term "run down" is not merely a popular phrase, but a scientific statement. Your body tends to run down like a clock, and unless you wind it up occasionally by a vacation it will break down and demand rest—at a sanitarium.



How a Vacation "Winds You Up"



The chart above, showing how various ways of spending the summer affect vitality, was compiled from actual tests by the Crampton system.

The history of the ups and downs of human vitality during spring and summer is revealed in the chart at the left: the record of experiments with Doctor Crampton's tests on 100 brainworkers.

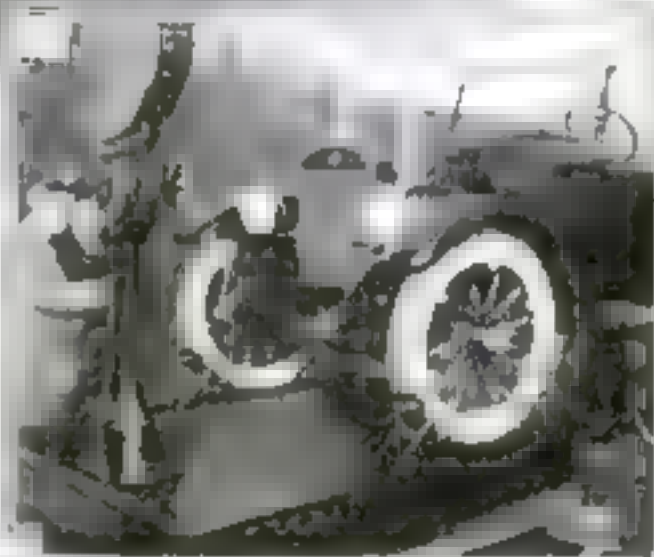
Odd News of the Month Gathered by Camera



Breakfast on Horseback

Breakfast from the saddle was the novel social diversion presenting a recent Horse Show at Santa Barbara, Calif. The guests dined at a high table elaborately set with silver and crystal. The horses proved so docile that a course breakfast was eaten from the saddle and not a drop of coffee was spilled.

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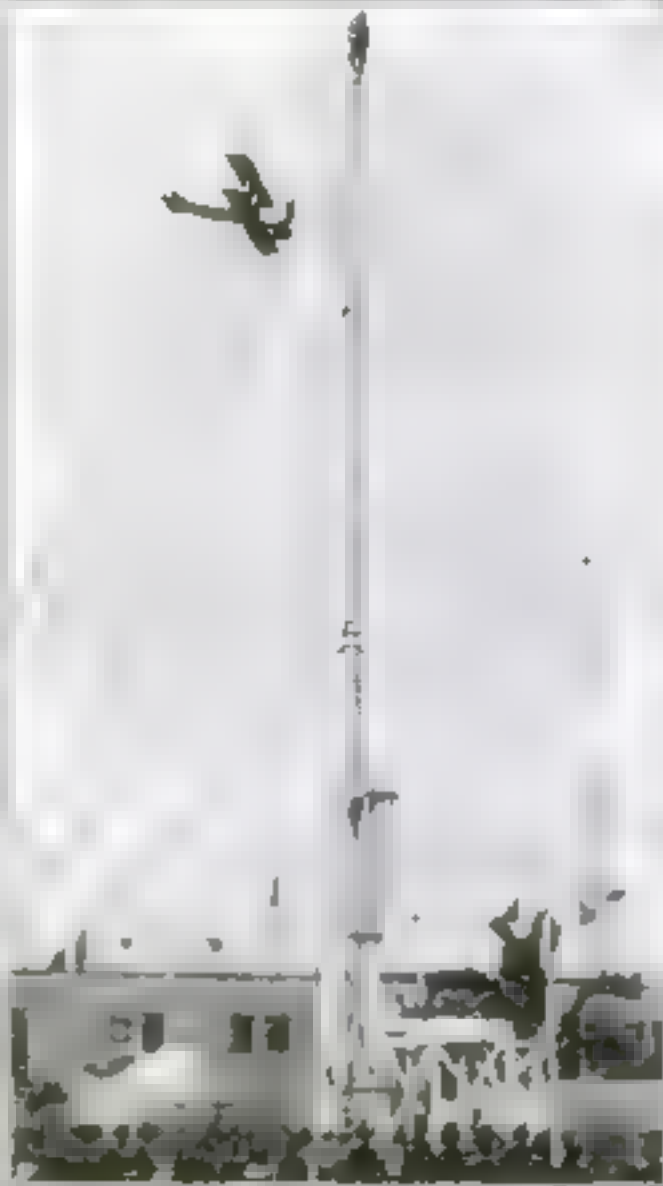
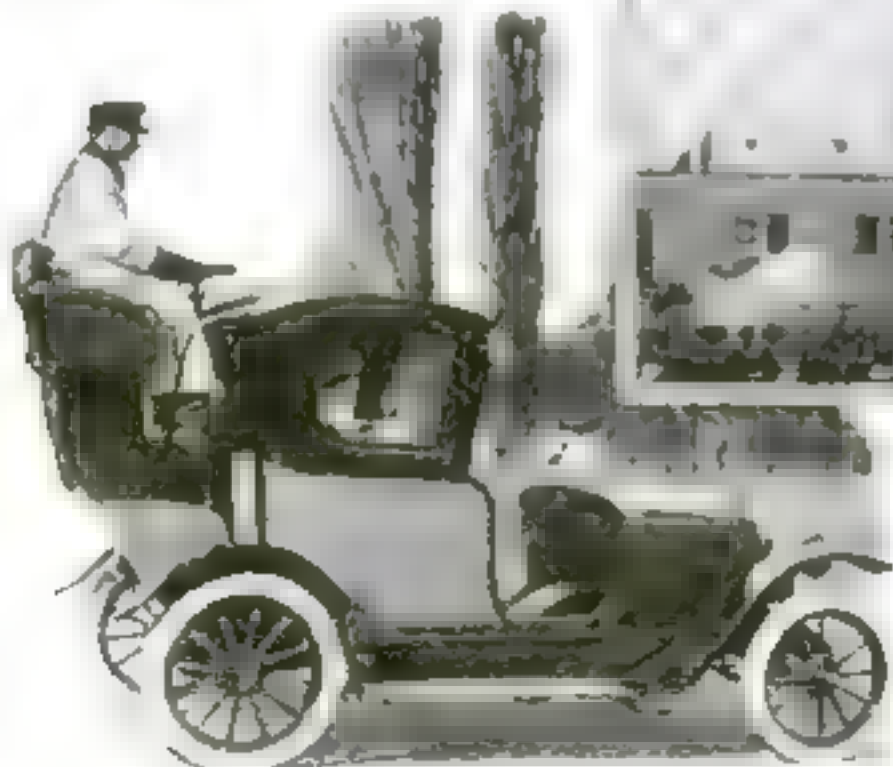


Airplane Is Roof Signboard

An airplane parked on a garage roof in London, England, serves as a roof signboard to attract the attention of passers-by. The machine is an actual service plane worth of its weight and purchased by the garage owner for advertising purposes.

Ride in a Hansom Taxi

Want a hansom? A modern version of the old hansom, reviving the joys of riding with an unobstructed view while the country peaches high in the rear may be seen these days in Paris. France in the form of a hansom taxi. This strange new motor vehicle is pictured below.



Dives from Clouds

When E. Ring (high-fancy diver) of Mount Beacon, Pa., climbed a ladder to a dizzy height for the longest dive on record an airplane hanging above photographed the spectacular plunge.

Scales Measure Vibration

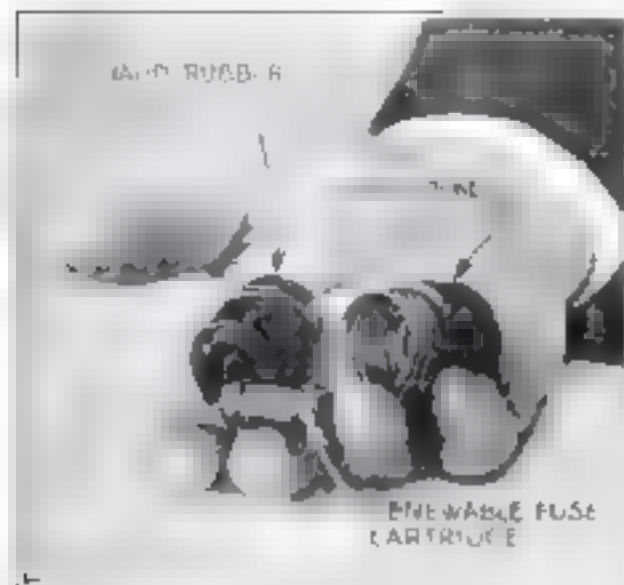
Vibration, one of the deadliest enemies of the motor, can now be measured accurately by a testing device consisting of a scale mounted on the front wheels of an auto, and a counter wheel for each wheel turn on the axle. A speedometer measures the rate at which the wheels turn.

An Automatic Camera

Drop a coin in the slot, look just a moment at the auto, and the camera will automatically take a picture. The camera is a box with a lens, a shutter, and a film, and is operated by electricity.



"THE inventor who can save us two cents a mile in gasoline will be wealthy for life."
—The London General Omnibus Company.



New Fuse Is Removable without a Shock

TO PREVENT delay that occurs when lights or machinery stand idle while a frantic search is being made for someone "who knows about those fuses," a new renewable fuse has been designed. With these fuses installed, any one can locate a blown fuse in the box and renew it without trouble or risk of an electric shock.

The cap and body are of heat-resisting, molded insulation. The refill, or fuse proper, is a little cartridge vented for the emission of gases when the fuse element vaporizes. No matter how the cartridge is inserted, the figures of its rating in amperes are always visible. After the refill is dropped into the body and the cap screwed on, all exposed parts are dead, making accidental shock impossible.

ELEVATORS in New York City carry as many people as ride on all the city traction lines, according to the Bureau of Standards. It is said that an elevator in the Woolworth Building travels 40 miles and makes 4000 stops a day.

Giant Squid Washed Aboard Steamer in Gale

WASHED aboard the steamship *Caronia* in a heavy gale far out at sea, a squid over five feet long was captured recently after a sharp



Eight tentacles and two tentacular arms are the squid's weapons

struggle on the slippery decks, and will soon be exhibited permanently in the American Museum of Natural History. This specimen of deep-sea squid is the first found since 1876, and it is thought to be the largest of its kind ever caught.

Sperm-whales battle with squids of this type in the depths of the ocean, and the struggle is by no means uneven. The squid defends itself with eight tentacles and two

Light of Huge X-Ray Tube Pierces Wall

X-RAY tubes have increased in size and power until their light can penetrate brick walls a foot or more in thickness, and take photographs of objects 150 feet away.

One of the most powerful tubes ever manufactured has been developed in an

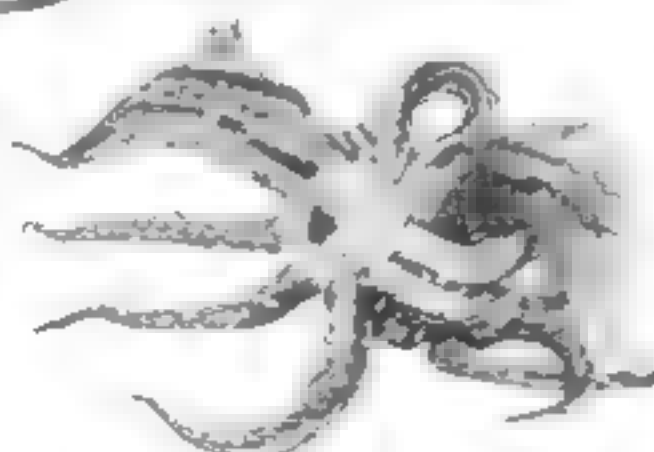


Light from this X-ray tube can penetrate a brick wall a foot thick

American laboratory and is pictured above. The unusual size of the terminals and an improved cathode permit these tubes to be operated with a 300,000-volt current—a voltage higher than that of most high tension transmission lines.

long tentacular arms with which it grasps its antagonist. The tentacles are armed with double rows of suckers, in each of which the squid can produce a vacuum, so that the suckers will fasten to a fish's scales, or actually burrow into the flesh of a soft-skinned creature. On the inner surface of each sucker is a ring of horn, serrated like the teeth of a saw.

The mouth is a round opening at the base of the tentacles.



Protruding from the base of the tentacles is a sharp beaklike mouth

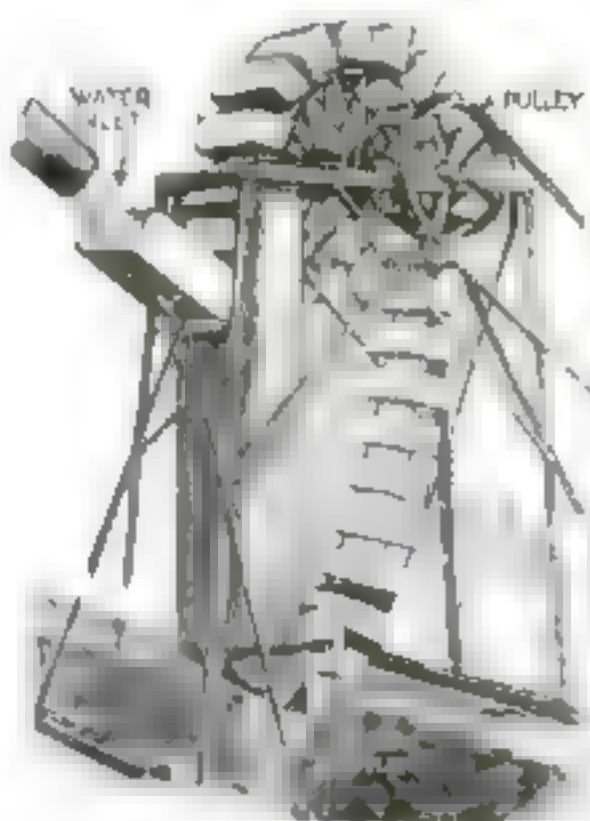


Wrench Automatically Fits Itself over Nut

AN ADJUSTABLE wrench that locks automatically on a nut by a movement of a thumb-catch is among the newest inventions for speeding up work. The wrench can be operated with one hand. When the catch is released, a spring incorporated in the jaws brings them firmly in contact with the nut, and a ratchet lock holds the jaws in place.

The thumb-catch is placed where it can be operated without shifting the grip on the wrench handle.

Bucket Chain Increases the Power from Small Falls



THE horsepower obtained from small falls can be doubled by the use of an improved bucket chain operating on the principle of an overshot water-wheel, claims J. W. Freeman, the inventor.

The secret of increased power output, he says, is the wooden chute through which the buckets travel while full of water. Strung on an endless conveyor, the buckets are filled at the top of the chute, as water is admitted to them by a chute from the intake. While the designer has not attempted to make a watertight joint between the buckets and the chute, the clearance is small. The inventor believes that his machine will find its chief use on streams too small to be harnessed by the overshot wheel.

How Many Cows in the Herd?

Try Your Hand at Sam Loyd's Puzzles on This Page
Best Solutions Win \$25

A WESTERN ranchman announced that he proposed to distribute a small herd of cows among his children.

"Now, John," he said to the eldest, "you

may take as many cows as you can care for, and your wife may take one ninth of what are left." To the second son: "Sam, you may take one more than John took and to your good wife I will give one ninth of what remains."

In like manner he dealt with the next son, giving him one more than Sam took, and to his wife one ninth of the remainder. Thus he continued with the younger sons and their wives until the entire herd was disposed of.

It then became apparent that the distribution had been most equitable, for each of the seven families received a like number of cows.

How many cows were in the herd?



\$25 in Prizes for Best Answers to Puzzles

A FIRST prize of \$10 will be awarded for the best set of answers and analyses covering the three problems on this page; a second prize of \$5 for the next best set; and 10 prizes of \$1 each for the 10 next best sets.

Answers must be received not later than August 1, addressed to the Puzzle Editor, Popular Science Monthly, 225 West 39th St., New York, N. Y.

Answers to the puzzles on this page will appear in the September issue; the names of prize-winners in November.

July Puzzle Answers COUNTING THE RECTANGLES

The rule for finding the number of squares in a square diagram made up of smaller squares, is to add together the squares of the horizontal rows, numbered in arithmetical progression. In the 4 by 4 square, this would be—1 plus 4 plus 9 plus 16—a total of 30. To find the number of rectangles, take the square of the sum of the rows, numbered in arithmetical progression, viz., 1 plus 2 plus 3 plus 4 equals 10, which squared gives 100 as the total.

BRICK FACTS

A whole brick weighed 3 pounds, and 17 2/3 bricks filled the hod.

DEALING IN HORSEFLESH

One horse, costing \$220, sold for \$198, a loss of 10 per cent. The other animal, costing \$264, sold for \$296.68, which showed a profit of 12 per cent. Total cost \$484. Sold for \$493.68, a profit of two per cent on the whole transaction.

Prize-Winners for May

FIRST PRIZE, Ten Dollars: G. G. Williamson, Oxnard, Calif.

SECOND PRIZE, Five Dollars: G. M. Thibodeau, Halifax, N. S.

Ten One-Dollar prizes: A. Fick, Boone, Iowa; L. H. Moulton, Delta, Utah; Irving B. Thorner, N. Y. City; William Bach, Chicago, Ill.; E. Frederick Skinner, Susquehanna, Pa.; W. H. Elkins, Topeka, Kans.; R. H. Wetherbee, Norman, Okla.; Harry Lee, N. Y. City; A. G. Kalmbach, Grand Rapids, Mich.; Nathaniel Myers, Swarthmore, Pa.

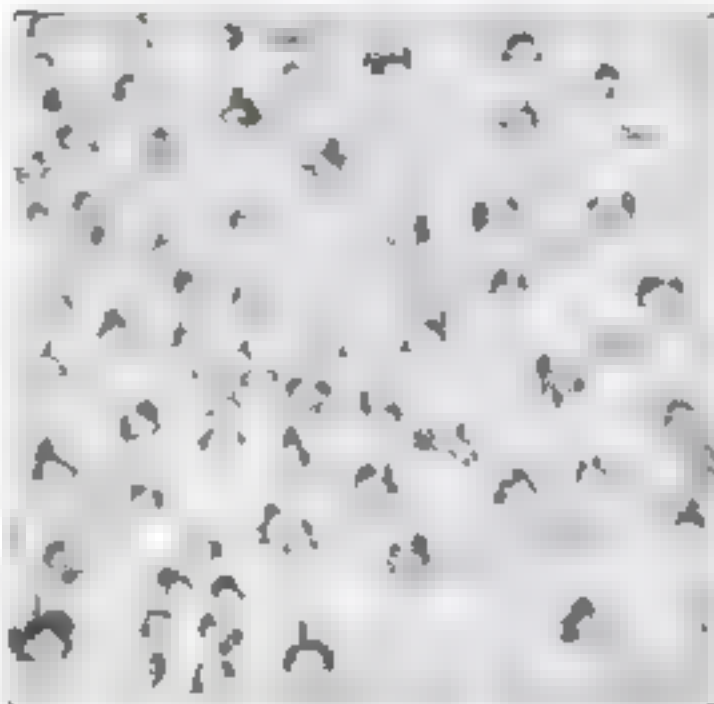


The Magic Square Reversed

IN THE sketch we see the Magic Square in simplest form, the numbers so arranged that in each row, column, and two diagonals, the total is 15.

Now, let us reverse the proposition and rearrange the nine numbers so that we shall have eight different totals for the eight sums, leaving the 5 in the center.

Can You Divide the Land Correctly?



WHEN the stockholders of the Square Suburban Homes Company dissolved the corporation, the square piece of land with its cottages was distributed among the 11 stockholders in proportion to their respective interests.

Now, it so happened that no two of the interested parties held similar amounts of stock, so in the apportionment, when each of the 11 owners built a fence around his holding, no two inclosures held a similar number of houses.

Who can show how the community might have looked after the division, by drawing across the square the fewest possible number of straight lines, representing fences, which will create 11 inclosures, no two to contain a like number of houses.

One Man Operates Tractor Road Scraper

A NEW road scraper that requires only one operator simplifies the problem of maintaining country roads by combining in one machine a light gasoline tractor and a readily controlled scraper. The combination forms a four-wheeled unit that can be steered backward or forward as easily as an automobile, and which can turn around

in about the same space. The speed ranges from 1 1/2 to 3 miles an hour.

The power unit is a general utility tractor of 12 brake horsepower. The grader is specially designed, with the height and slant of the blade controlled by two hand wheels with worm gears. The blade is also secured to a horizontal circle to permit adjustment of the angle between the blade and the direction of travel. The blade drawbars are attached directly to the drawbar of the tractor to provide a direct pull at the correct height.

The grader wheels are 32 inches in diameter, with three-inch flat tires. The blade, six feet long, has a detachable cutting edge. It weighs 4265 pounds.

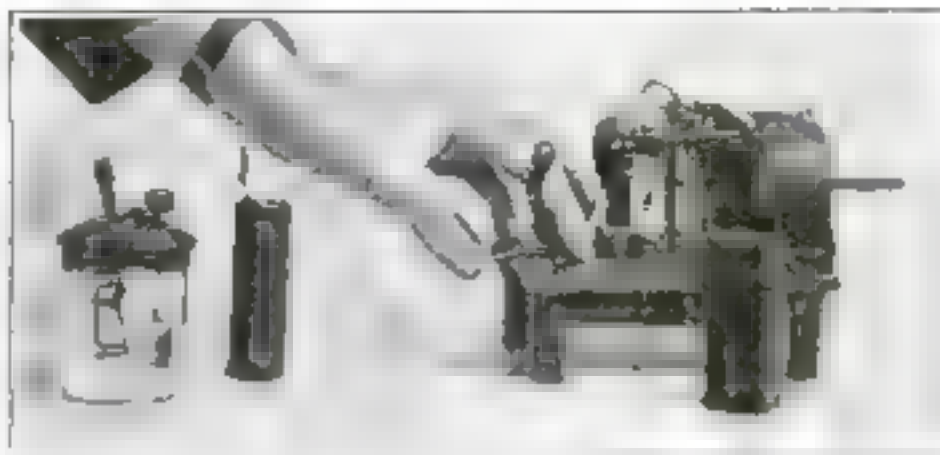


The combination tractor and scraper

World's First Wireless Outfit Found in London Tenement

THE crude but sensitive instruments with which David Hughes first discovered wireless waves have been unearthed in a London, England, tenement and transferred to a place of honor in the South Kensington Museum. Hughes experimented with electric waves long before Marconi, but the latter gained the distinction of being the discoverer because he was the first to recognize them as ether waves.

The newly found instruments consist of a spring wound device that sent out electric impulses at regular intervals, and a carbon microphone used by Hughes as the detector. History tells us that during an experiment in 1879 Hughes started the transmitter and then walked slowly away from his laboratory with the receiver in his hand,



A carbon microphone detector, battery, and crude automatic transmitter make up the first wireless outfit

noting how far the sounds could be detected. At times he was able to hear them 600 feet distant.

Although Hughes was an extremely able scientist, he lived and worked in a frugal manner. Most of his instruments were made up of odds and ends, such as pins, needles, scraps of wire, and pieces of metal

utensils. Yet even with these he was able to produce delicate mechanisms that were the forerunners of those in operation today. The carbon grain transmitter was first studied by Hughes and a widely used electrical device known as an induction balance was invented by him. Later he published a theory of magnetism that brought him distinction.

Hughes was born in America, where he lived during his early years; but

after inventing a printing telegraph he moved to England and the Continent. There he tried for many years to have the machine approved by foreign telegraph firms. Finally, after being accepted by the French government, it was adopted by all the leading companies and brought wealth to the inventor.

Mechanical Driver Tests Flight of Golf Balls

A GOLF-BALL testing machine recently produced can, in successive drives, send a ball always in the same direction and to the same distance.

The flight parabola of a golf ball depends on minor characteristics. If the cupped markings are uneven or if they are too shallow or too deep, the curve of the ball will be irregular. The new machine tests the balls individually, and if the performance is not always the same, the fault is discovered and corrected.

In operation the machine is set up on the testing links with a driver inserted and after the ball is carefully placed on the



Heavy weights supply the power that swings the golf club

tee, and an attendant winds up heavy weights, a spring on the machine is released. Because of the mechanical setting the impact is perfect. The force exerted by the machine is about 600 pounds.

READ in the Home Workshop Department, how to make a boat landing for your summer camp or cottage.



Around the place where the rays strike, a lead protective pad is placed on the patient's body

Alternating Current Adds Power to X-Ray

PHYSICIANS expect that an X-ray machine developed by Frank Reiber, of San Francisco, will be powerful enough to mark a notable advance in curing cancer. Reiber has doubled the effectiveness of the machine by adding an alternating current, in which the pulsations in the X-ray tube come alternately from two directions instead of one. Cancers that lie too deep for ordinary X-ray treatment can thus be reached, it is believed.

The use of 16-inch X-rays, operated at 240,000 volts, necessitates great care in protecting the patient.

A tub of lead confines the rays, which escape only through a hole in the bottom of the tub. A lead protective pad with a hole in the center, placed on the patient's body, keeps rays from striking parts not under treatment. A window at the side permits the attendant to see that the ray is working properly, and an ampere meter at the top prevents the amperage from rising too high.



Adjustment of the nozzle changes the angle of the stream

Water Pressure Lifts and Holds Hose Nozzle

BY TURNING a stream of water from the straight path, E. E. Thomas, of Portland, Oregon, has invented a fire hose nozzle that automatically holds itself erect at any desired angle as long as the water flows. The principle employed is based on the force of reaction of water when an attempt is made to change its direction.

Water pushed through the hose reaches a point where the nozzle is bent slightly downward. The tendency of the stream is to bend the metal back into a straight line, but since it is unable to do this, the water exerts a force that lifts the bent section upward. When this force becomes equal to the weight of the nozzle plus that of the hose attached to it, the movement ceases and the nozzle maintains its position.

When the water is turned off, the nozzle falls to the ground; but when the pressure is restored, it raises itself to the same angle as formerly. This angle may be changed by adjusting the bend in the nozzle.

Pump Converts Auto into Fire Engine



How the turbine pump, with fire hose, is attached to an automobile crankshaft is shown in this "dummy" demonstration truck

FOR the purpose of giving the rural community adequate fire protection at small expense, any automobile can be converted into an efficient fire engine when equipped with a high speed turbine water pump recently invented by Mario Tamini, an engineer in Italy.

The pump, which runs from 2000 to 3000 revolutions a minute, can be fitted directly to the crankshaft of a car. A .2-horsepower motor will deliver 155 gallons of water a minute, or a solid stream from a 1 1/4-inch nozzle at a pressure of 85 pounds. This model weighs only 77 pounds.

Larger pumps, which can be used by high power cars, will throw a stream of water a distance of 180 feet, or 115 feet in the air. This makes a favorable comparison with the best city fire engines.

The pump may either be fastened to a car, or mounted on a two-wheeled trailer fitted with a small high power gasoline engine. In the latter case, the whole unit can be hauled to a fire either by horses or by the first auto that reaches the fire house after the alarm is given.

If mounted on a portable frame, two men walking tandem can carry both motor and pump.

Battery Heats the Blade that Unseals It

ELECTRICALLY heated blades fed with energy from the storage battery they are unsealing have been perfected by a Michigan company. The blades are connected through a wooden handle with test clips by short lengths of wire covered with pure paraffin, which protects them against the acid.

This device is said to be superior to a gas flame because the heat, carried direct to the point where it is needed, remains at a constant temperature while the work is being done. The absence of an open flame also completely eliminates the danger of igniting the escaping gas.



This tool unseals the battery with the battery's own current



Glass Container Keeps Plant Label Legible

FOR the amateur gardener plant labels that are weather and dirt proof have just been patented in England. The label is written on a strip of oiled paper and slipped inside a small flat glass tube closed at one end and finished with a ring, by means of which it can be tied to the plant.

A small rubber cap fitting over the end of the tube makes it waterproof. The label will remain legible for the growing season.

Chain on Sprocket Wheel Turns Steam Valves

EASILY strapped into place in 10 minutes, a standard adjustable sprocket rim wheel for chain manipulation of valves can be fitted to any of the thousands of types of valves in use in steam plants.

The advantage of the chain in opening and closing valves is that complicated pipe layouts are unnecessary to keep all valves within reach from the floor. The standardized wheel avoids the expense of purchasing special valve-closing mechanisms for every valve.

A deep recess in the rim and a simple guide keep the chain from slipping off the sprocket wheel. Instead of fitting on the valve stem, the sprocket wheel is attached to the valve wheel. Three hooked bolts are slipped under the valve wheel, and the sprocket wheel is centered by moving the bolts backward or forward in slots cut in the rim.

When the wheel is centered, the nuts on the bolt ends are tightened with a monkey wrench.



Turning a valve by a chain



Gophers Commit Suicide with Shotgun

A SAWED-OFF shotgun loaded with a deadly charge of powder and balls forms the basic part of a new gopher gun invented by George E. Clark, of Lincoln, Nehr.

In setting the weapon, a hole is scooped out of the entrance to the gopher den and the gun is set with the muzzle pointing inward. The trigger is attached to a trip that is unlatched by a rod extending in front of the gun down the opening. The gopher, in leaving his nest, strikes the rod. This unlatches the trigger and the heavy charge is shot full into the head of the rodent. In one exhibition held in a field overriden with gophers, 50 guns yielded a perfect score of 50 pests.

The gun is loaded by unscrewing the black iron barrel, pulling out the firing pin and inserting an ordinary .410 gauge shell.

Surplus Rubber for Fuel

SCRAP rubber is being used successfully in Java as a substitute for firewood in firing locomotive boilers, it is reported. Results of exhaustive experiments indicate that this fuel may also be used in the Java sugar mills.

How One City Crushes Tons of Germs for Fertilizer

New Process Saves Sewage Waste

A PROFITABLE method of returning to the soil a great portion of the plant food value removed from the land each harvest and now thrown out in our sewers to contaminate stream and ocean, seems assured at last with the perfection of a successful process of squeezing dry the jelly-like sludge produced from sewage by myriads of microscopic, greedy bacteria.

The "activated sludge" process of sewage treatment, by which sewage is converted by bacteria into its original elements—water and sterile organic matter—originated in England and has been used extensively in American cities. But the problem of economically transforming the wet sludge so produced into commercial fertilizer has been a baffling one to sanitation experts.

Houston's Sewage Yields Cash

By the perfection of a new process of removing the water from sludge, the city of Houston, Texas, apparently has solved the problem, opening up to the farmers of the nation a tremendous potential supply of cheap fertilizer.

The waste in present methods of sewage disposal, not to mention the cost of sanitary disposal itself, is enormous.

Every year 1,825,000 tons of fertilizer is carried to the sea in sewage emptied into our streams—enough to fertilize 5,000,000 acres of land.

Every year 800,000 tons of Chilean nitrates are imported to help replace the plant food values thus thrown away.

Each million gallons of sewage waste is capable of producing 1.5 tons of dried fertilizer. At \$25 a ton, the actual money loss represented in the annual sewage waste is \$45,825,000.

And in addition to this loss are the millions of gallons of water used in domestic consumption and thrown away, that could be converted to agricultural irrigation purposes.

In every city disposal of sewage has always been regarded as a necessary, ex-

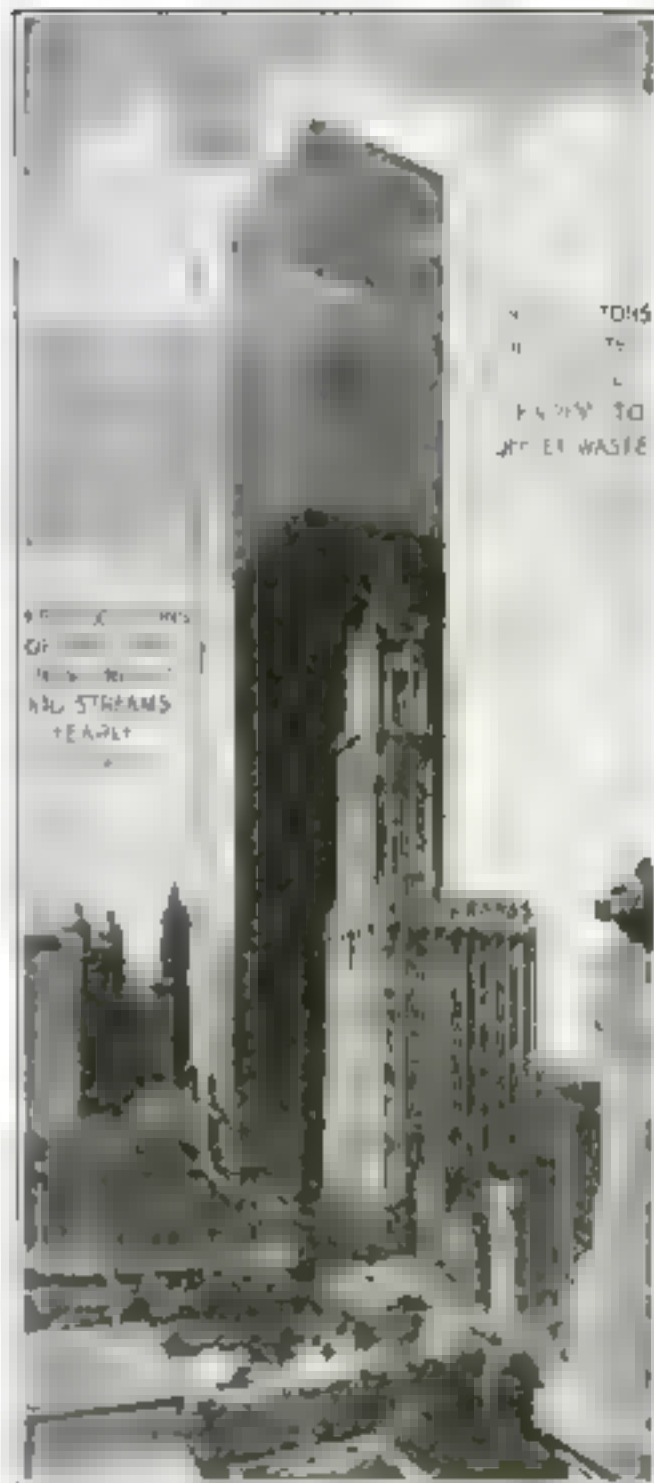
pensive obligation. In most cases sanitary disposal has been not only costly, but destructive. The cost has included chemical treatment of wastes and carrying the water away to some natural body of water. The chlorine treatment alone costs from \$3 to \$6 a million gallons, and sometimes more. To add to the problem, outpourings of sewage from large cities into the ocean form a harmful nuisance along the seacoasts. The Atlantic seaboard from Maine to Florida is more or less contaminated everywhere. A recent government hearing disclosed that sea disposal of sewage and industrial waste is destroying the Atlantic coast fishing and shellfish industry, besides making the beaches objectionable and unsanitary.

The whole method of "activation," which until now has been only partially successful, hinges on the activities of the bacteria in sewage when they are supplied with plentiful quantities of air and light. During the process, the sewage is circulated slowly through open-air tanks, and throughout the length of the tanks compressed air is bubbled up through the sewage. To speed up the growth of the bacteria, a small amount of the sewage from the end of the tanks is pumped back to the inlet for the purpose of inoculating the fresh sewage.

Making Use of Hungry Bacteria

At the end of about four hours of circulating through these tanks, the little microscopic organisms have actually eaten up all of the solid matter in the sewage. There remain only crystal clear water, which flows off the top of the tank, and countless bodies of dead bacteria, which settle in a jelly-like mass at the bottom. This jelly-like sludge is pumped out of the bottom of the tank.

The chief difficulty heretofore has been the treatment of the sludge. If allowed to stand in the open, the jelly-like substance decomposes rapidly and becomes a nuisance. But in spite of this the usual



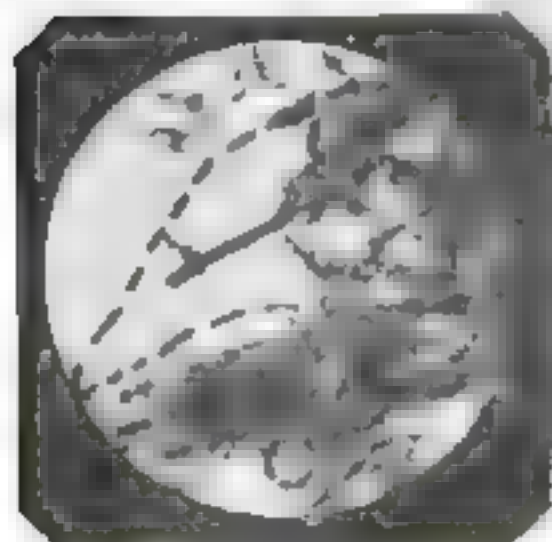
A Tower of Waste

Sewage emptied from our cities into streams and oceans each year would make a pile of fertilizer as high as the Woolworth Building, covering an entire New York City block and containing 1,825,000 tons. To help replace this tremendous plant food value, utterly wasted, America imports each year 800,000 tons of Chilean nitrates.

method of disposal has been to pump the sludge into pools and then to release it into a convenient stream at times of high water. This wasteful method took no account of the fact that the sludge contains the ingredients of a valuable fertilizer.

Before it can be handled commercially as a fertilizer the water must be pressed or drained from it and the final product must be dried until it contains only about 10 per cent moisture. The jelly-like consistency of the sludge has made this impossible and ordinary drying methods have failed to solve the problem.

The sludge, it has been found, can be partly dewatered by the use of the standard type of frame-and-plate filter press, but this is a slow, cumbersome, and expensive process. Centrifugal machines failed because the bodies of the little bacteria were so nearly the specific gravity of water that they would not "throw" out. In this state the problem of dewatering activated sludge remained for a number of years, though sanitary experts all agreed that if the problem



In this remarkable photograph of activated sludge, magnified 2000 diameters, what appear to be minuscule strings of sausages are the tiny bacteria that literally eat up the solid matter in sewage.



The world's largest activated sludge plant at Houston, Texas. Here the sewage is pumped slowly through open air tanks, shown above, while compressed air is forced through it. To speed up bacteria growth, sewage from the end of the tanks is pumped back to the inlet, inoculating fresh supplies. After about four hours of this process there remain only a jelly like mass at the bottom of the tanks, made up of the bodies of myriad bacteria, and clear water flowing above.

EVERY million gallons of sewage, now wasted, represents more than a ton of dried fertilizer, containing 3.5 per cent nitrogen and worth \$25 a ton. Pasadena, Calif., salvages 3,000,000 gallons a day.

could be solved, the system would come very close to the ideal.

The first step in the solution was the discovery by Angus MacLachlan, of New York, that if sulphur dioxide gas is introduced into the sludge, its jelly-like consistency is broken down so that it can be handled by ordinary commercial drying methods.

The Houston sewage disposal plant, which is at present the largest of the kind in the world, was already in operation when Mr. MacLachlan suggested his process. The initial experiments gave great promise of success. A rotary sulphur burner was installed to generate the needed sulphur dioxide gas, and this gas is blown by steam or compressed air into the tanks containing the sludge. The sludge appeared immediately to lose its jelly-like texture and sank to the bottom in a compact brownish granular mass. The gas appeared to have, in addition to its chemical qualities, an electrolytic effect, for it caused the microscopic bodies to coagulate. The resulting mass resembled wet paper pulp in consistency.

A number of methods for drying this new type of sludge were tried with indifferent success.

One of the first was to pour the wet sludge onto sand filter beds, allow the water to drain off, and then collect the sludge layer for final drying in an ordinary direct heat rotary dryer. It was found that the standard type of filter press could be used to better advantage than formerly, but by either of these methods the cost of drying was still dangerously near the final market value of the product.

Details of the Salvaging Process

Then the idea was hit upon of spreading the sludge in a thin sheet and continuously pressing it between heavy rollers. The apparatus designed for this process consists of a tank into which the wet sludge flows through a pipe. Inside the tank is a large hollow cylinder, covered with a fine mesh wire screen, so arranged that the water drains through the mesh into the center and then flows off at one end of the tank, while the sludge collects on the screen and is carried up and under a heavy roller on top. This top roll presses the sludge, picks it off the larger roll, and carries it up and over, where it is scraped off by contact with a beveled board.

The sludge removed in this way is collected and finally dried in direct heat dryers. A large machine constructed along similar lines is now being installed to de-water continuously all the sludge that comes from this plant. Data obtained from the tests indicate that the drying costs will be reduced from nearly \$40 a ton, where the sulphur-dioxide gas process is not used, to about \$3 a ton.

The importance of the process lies not so much in the immediate benefit to the city of Houston, but in the probability that many other American communities will adopt the plan. Already four large acti-

vated sludge plants are under construction. There are a number of smaller plants contemplated or in operation and it is estimated that the combined fertilizer output of all plants now operating or under construction will be about 5000 tons a year.

The value of this potential fertilizer sup-

plied, its adoption by many American cities may be expected.

Pasadena, Calif., is one city that is profiting by the process with striking success. This city owns and operates a 530-acre farm, which is irrigated and fertilized by the city's sewage system. According to Bert C. Bougher, superintendent of the Pasadena city farm, the use of sewage as fertilizer has doubled the production of orange trees and has resulted in immense yields of potatoes and corn.

The city recently voted a bond issue of \$325,000 to complete the most modern activated sludge plant that science has devised. This sum will provide for the construction of sufficient units to take care of 7,000,000 gallons of sewage. At present about 3,000,000 gallons of sewage a day are entering two tanks on the city farm.

The potential value of 1,000,000 gallons of sewage as disposed through the activated sludge process is given by Superintendent Bougher as follows:

"Fertilizer from sludge, 1.4 tons from 1,000,000 gallons, 3.5 per cent nitrogen; value, \$25,

"Water at agricultural rates, three acre feet from 1,000,000 gallons at \$8 the acre foot, value \$18. Total value, \$43."

Figuring the probable volume of sewage coming into the Pasadena farm when the new tanks are completed at 5,000,000 gallons every 24 hours, he gives the potential value of municipal wastes as follows.

What Pasadena Saves

"A total of 7.5 tons of dried organic sludge a day, or 2700 tons a year in round numbers, with a market value of \$25 a ton figured on nitrogen content, represents an annual value of \$67,500.

"Four hundred inches of water valued at one cent an inch an hour, amounts to \$96 a day, or a total water value for the year of \$35,000. This gives a grand total potential return from 5,000,000 gallons of sewage a day of \$102,500 a year.

"The total cost of handling the water and drying the sludge would be about \$187 a day, or \$69,955 a year. The annual net revenue from the sewage would, therefore, be \$41,545."

The success of Houston's new process and Pasadena's city farm in transforming the city's waste from destructive loss into actual profit, merely indicates the possibilities that are open to other cities in advantageously solving one of the nation's most pressing problems.

It is not anticipated that activated sludge fertilizer will entirely replace Chilean nitrates. It is likely, instead, that the total output of each plant would be absorbed in the immediate vicinity. Those farmers who are within trucking distance of such plants will be most benefitted. In this way activated sludge may be expected to become a valuable supplementary fertilizer supply, which, because of the increasing fertilizer requirements, will cause no startling revolution in our imports of nitrates.



This experimental machine for removing water from sludge, adopted at Houston, Texas, has made possible the successful transformation of sewage into fertilizer. Wet sludge flows into the machine through the pipe at the left, where a hollow drum inside the tank slowly revolves. Collecting on the drum, the sludge is carried under a roller. The water drains through a fine mesh wire covering the drum and flows out of the tank into the trough. Dry sludge, clinging to the small roller, is removed by scraper

ply, which now is spread out on the floor of the sea, may be realized from the fact that activated sludge contains about six per cent ammonia. Organic ammonia of this type, when placed in the soil, is converted into nitrogen, one of the most important and the hardest to procure of the essential plant foods. Our present supply of fertilizer nitrates comes chiefly from Chile, where there are large natural deposits. Some 800,000 tons are imported each year, with a purity averaging about 60 per cent.

The fertilizing value of activated sludge, however, goes beyond the figures already quoted. In the first place, the organic matter that largely composes the sludge slowly decomposes in the soil and adds further plant food value, in about the same proportion that plant growth withdraws it. Secondly, while Chilean nitrates are in a form readily soluble in water and are likely to be partially washed away by heavy rains before they can become effective, the organic ammonia unites chemically with the soil and is held in stable form until withdrawn by plant growth.

Lost Soil Values Are Restored

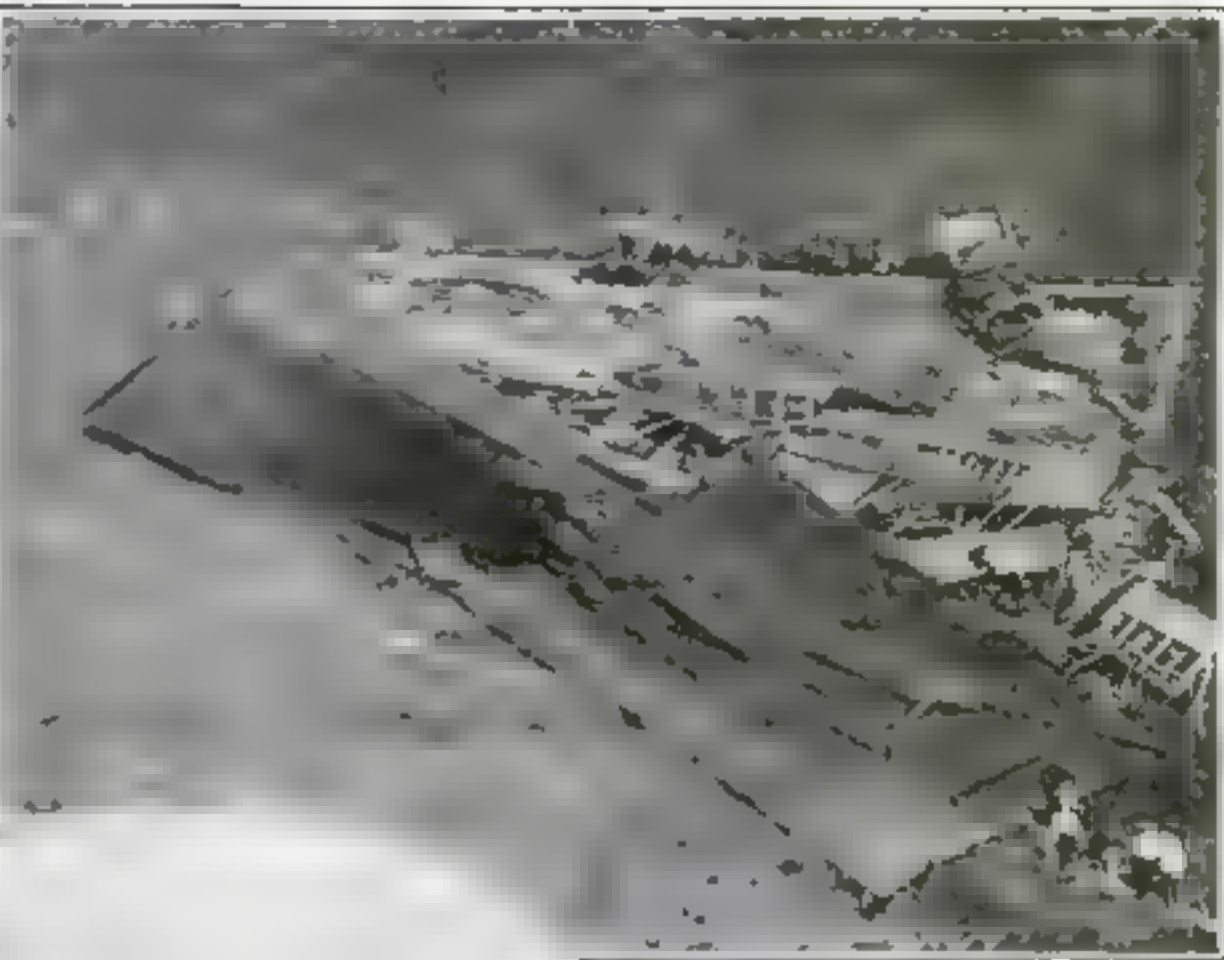
The most forceful argument in favor of the Houston type of sewage disposal plant, perhaps, is that it offers the only system at present that recovers the values contained in sewage in a commercially salable form. It has been realized for a long time that sewage contains a large part of the very soil values removed from the land with each crop that is harvested, and that quite aside from the monetary value of these products, they ought to be returned to the soil.

The activated sludge process, because of its sanitary features, has attracted wide attention in recent years, and now that the final objection appears to have been re-



A Vanity Searchlight

In the glow of the tiny vanity case searchlight shown above, a woman can powder her nose even in the darkest taxicab or theater. The light is connected with a spring switch in the box lid and goes on automatically whenever the case is opened. It is sufficiently brilliant to illumine the face of the owner, and is handy for keys to the door.



Truck Wrecks Building

One "kick" from a five ton truck knocked a building into this flattened mass of splintered timbers. The structure was used as a warehouse for the United States Marine Corps in the Panama Canal Zone. One morning recently, a private, driving an army truck loaded with coal, backed his truck up to the side of the road to deliver coal to a ship. The truck went too far. As its rear end collided with the wall of the building, the whole structure collapsed. The impact of five tons caved in the four walls, and the roof came tumbling after.

Bullback Riders

Running a thousand feet long, a bull is a powerful animal. Three fourths of a mile to get the road is a heavy duty job. The bull has been broken to give the animal exercise. His owner recently rode the bull 24 miles in 4 1/2 hours, and the animal appeared to enjoy the trot as much as his rider.

The bull is growing big and powerful as a result of the exercise and constant handling keeps him gentle. The saddle method, it is reported, is more effective than putting him through a series of exercises.

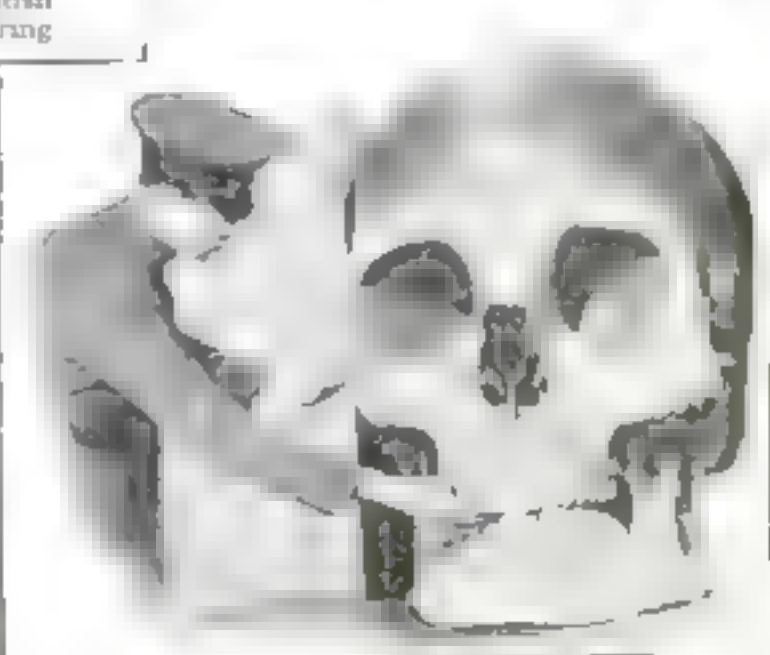


How Farmers Work on Stilts

Stilts are more than playthings in the British Isles. In the trials of string, one worker on stilts can do as much as six working from stepladders. Strangely enough, stilts are used almost solely by farmers who come from the county of Kent, in England. The worker's feet are strapped in shoes attached to the rests, and the top ends of the stilts are securely fastened by a strap that passes around his waist. If he loses his balance he is likely to have a bad tumble.

World's Largest Skull

The largest skull in the world, four feet high, stands in the United States Army medical museum at Washington, D. C. It isn't a real skull, of course, but an exaggerated imitation, constructed for the purpose of anatomical study. Since the human skull is about one seventh the height of the body, a skull of the size of the one shown below would represent a body of 28 feet.



Automatic Pilot Controls Advertising Balloon

SMALL balloons, each equipped with a device for dropping sheets of paper over the countryside, and controlled by automatic pilots that throw out ballast in the form of printed matter whenever the balloons start to descend, may soon be used in political and advertising campaigns. The mechanism is the invention of R. C. Pierce, of New York City, a former captain in the United States Army Air Service.

The automatic piloting and distributing device is interfunctioning. The pilot consists of a tight case containing a small gas holder. An increase in atmospheric pressure as the balloon descends, forces down a ball in the gas holder, closing an electric circuit and throw-



As the distributing device travels down the suspension cord, revolving shafts feed sheets of advertising matter through slots in the bottom of the box. Meanwhile an automatic pilot checks the balloon's descent when necessary by throwing out paper ballast.

ing in a clutch. This clutch causes a ballast shaft carrying printed matter to rotate one revolution, releasing sufficient ballast to check the descent. At the same time the electrical contact opens a magnetic valve and restores the pressure equilibrium within the automatic pilot.

Included in the box that contains the automatic pilot is the distributing mechanism loaded with 80 pounds of printed matter and attached to a 300-foot cord hanging from the balloon by friction rollers, which grip the cord. At the start, the box is within a few inches of the balloon. After release, it constantly travels down the rope by the influence of its own weight. The rate of descent along the cord is controlled by a small centrifugal governor connected with the rollers.

Turning with the rollers are shafts, threaded right and left, on which is hung the material to be distributed. Rotation of the shafts causes the paper to feed off the ends and down through slots in the bottom of the device at the rate of 20 a minute.

To distribute a full load of propaganda and bring the device to the end of the suspension cord, takes about eight hours. The distance covered depends on the wind.



Brush Fences Make Flooded River Reinforce Its Own Banks

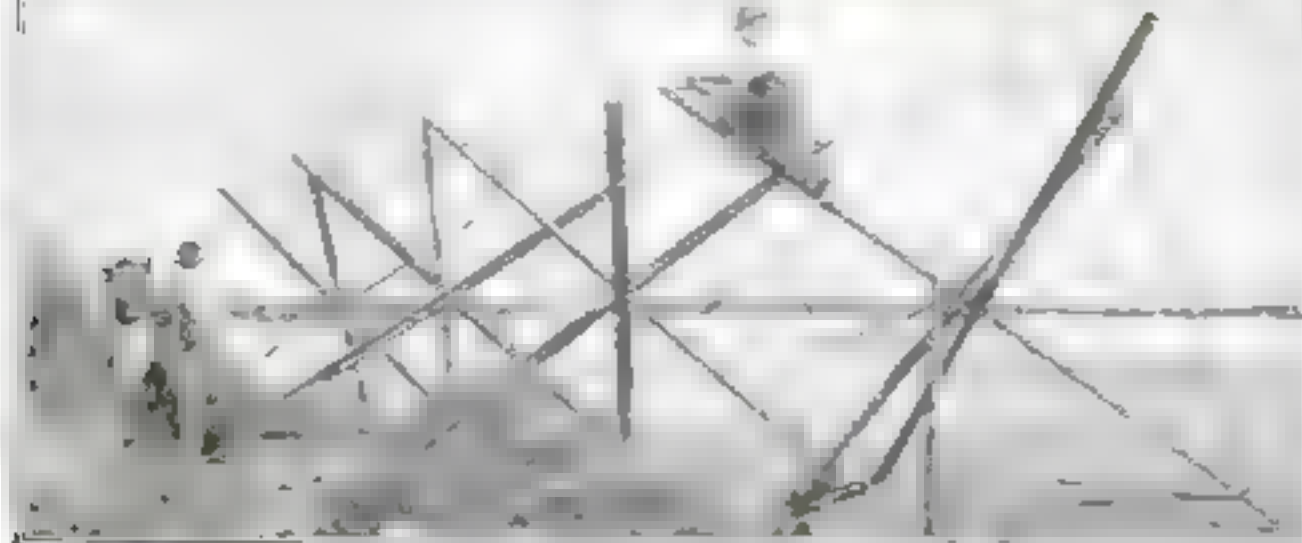
THE flood of tearing away fertile farm land, a "silt accumulator" has been devised by Harry F. Koelner, of Silver Lake, K.

The basis of the device is a series of three logged frames, each made by fastening iron poles together with wire rope. The ends of the poles are anchored as far possible to the river bank by stones or stakes.

Wire connecting the frames are then filled in with masses of twigs and brushwood. The resistance of this mass of material, while not great enough to cause the flood to stop,



Retained by brush fences the flood river piles up silt along its banks. The construction of the accumulator is shown at the left.



is sufficient to obstruct the current and reduce its speed. During the flood the water piles up behind the brush fence, and as the rate of flow is reduced, the river drops behind it.

After a flood it is declared, a solid mass of sand and silt will usually be found in place of the flimsy brushwood obstruction, providing additional protection for the river bank in the future.

Germans Prove Value of "Brown Coal" as Fuel

FORCED under the terms of the Reparations Committee to export a large proportion of her coal production, Germany is using lignite, peat, and "brown coal," as fuels for her industries. Her success raises a question as to the value of billions of tons of these materials in the United States. They may form a future fuel resource should our bituminous coal supplies ultimately give out.

Peat is dug from open pits and molded into briquettes, which vendors in German cities sell by the piece from packs carried on their backs. For industrial use, brown coal is treated in a manner which

renders it a better fuel than the bituminous coal.

Although it will be many years before America exhausts the 1500 billion tons of bituminous coal still unmined, the United States Bureau of Mines has perfected a process that will make



How peat briquettes are peddled on German streets



Soft peat lying in deserted moor lands, is "mined" easily by shovels traveling on an endless belt which carries the fuel to waiting cars



Lignite and brown coal deposits in the United States representing billions of tons of fuel are indicated by black portions of the above map. The gray portions are the bituminous deposits



Another interesting method of mining "brown coal." This hill, below sea level, is being literally sliced to pieces for fuel

our tremendous lignite deposits, estimated at 2000 billion tons, commercially important should the price of bituminous coal increase.

Lignite is an imperfectly carbonized coal, which still shows the structure of the prehistoric wood and vegetation from which it is derived, and which has not been subject to the extremes of pressure and heat necessary to convert it into completely carbonized coal. It contains between 85 and 70 per cent of carbon in the raw state.

By removing the moisture and a considerable proportion of the volatile matter in retorts, the Bureau of Mines obtains a charred residue that possesses a heating value and a chemical analysis almost identical with that of anthracite coal.

The char is recovered from the retorts in pieces about the size of shelled corn, which can be used directly as steaming coal or molded into briquettes. About 10 per cent of binding matter is required.

The final product can be handled and stored like coal, and will stand weather conditions in storage fully as well.

Lignite and brown coal deposits exist in the United States in a broad belt several hundred miles wide and extending in a northeasterly direction from Texas almost to Ohio. There is another bed underlying the Dakota and Montana and a third in Alaska. Smaller deposits are scattered all over the United States.

How Camera Lenses Are Sawed from Glass and Molded

STEEL saws are used to cut slabs of optical glass into the small cubes used to make camera lenses. The saws consist of thin rotating steel disks with smooth edges. Diamond dust in cutting oil is smeared on the edges, which then grind their way through the slab and divide it into regular blocks.

The blocks go to a gas furnace, where they are placed in small crucibles and heated to the softness required for molding. Constant supervision is required, and a screen of heavy steel chains with a mica window in the center is hung before the furnace door to protect the operator's face from the heat.

That the finished glass may be free from in-

ternal strains, the temperature during the process must be controlled to fractions of a degree.

The partially melted glass is next dropped

into a die and a hydraulic punch presses it into the approximate shape of the finished lens. The rough is allowed to cool very slowly, and is tested for flaws before going to the grinding room.

Here the glass blank is shaped to the exact contour of the grinding wheel.

Coarse emery is used until the approximate curve is obtained, then fine emery with more accurate tools, and finally the glass is polished with wax and rouge until the lens will fit into a master gage with absolute precision.

Throughout the process of lens-making complicated mathematical computations and workmanship of the first order are necessary.



After optical glass is cut as shown above, the blocks are heated for molding in the furnace at the right





Stepladder Unfolds to Reach Top Branches

A NEWLY invented stepladder that can be converted into a straight ladder 15 feet high is now being used increasingly by fruit ranchers in the West. The device is especially useful in the orange groves, since it can be used as a stepladder when picking the fruit from the lower branches, or as a common straight ladder when harvesting at the top of the tree. The change can be made easily and quickly.

The ladder is hinged at the center. Swung into alignment, the two sections are secured firmly by a rod that hooks from one section to the top step of the other. The patent is held by Littleton A. Boyd, of Illinois, Illinois.

Iron from Magnetic Sand

MAGNETIC sand may be converted into pig iron by a new Japanese process in which the iron sand is combined with coke to form ferro-coke, from which iron is readily extracted. Japan has little or no iron in any form that can be easily mined, but magnetic sand is abundant throughout the empire.

Carves Iron Rosebush with Acetylene Torch

AN IRON rosebush, blossoms and all, made of metal shaped and welded entirely with an oxyacetylene flame has just been completed in Philadelphia by Steven Gavorn and is being exhibited to demonstrate the possibilities of modern welding. Even the wrinkles on the leaves and thorns on the stems have been imitated in a man-



The stems have even their thorns of metal shaped by Gavorn

ner astonishingly lifelike for so stiff and intractable a medium as iron.

The details were worked into the leaves by a hammer; but the blossoms and all the cutting, shaping, and joining were accomplished with the oxyacetylene torch.



Motor Coils Vacuumized in Dipping Tank

THE electric motor or dynamo comes to grief if anything goes wrong with the cotton insulation of the strands of wire in the coils. Compressed air is now utilized for taking every bubble of air from these cotton wrappings before the coils are impregnated with an asphaltic mixture.

The taped coils are lowered into the impregnating tank, and sealed shut. A vacuum pump is started, and simultaneously an enveloping steam jacket begins to heat the tank. Thus the coils are dried and vacuumized at the same time. The vacuum is gradually increased until it reaches a point suitable for the size of the coil, and then is maintained from three to six hours, after which a by-pass valve is opened and the asphaltic mixture introduced.

Die in File Handle Cuts Thread on Tool-Tangs

IN A new handle for files or other tools with square tangs, the handle is screwed on the tang. In spite of the fact that the tang itself has no thread. A thread on the inside of the handle acts as a die, cutting its own thread on the corners of the tang.

As the tang is tapered, screwing it into the handle applies a great pressure that expands the thread and locks the tool firmly into place.

The construction of the die-thread is most interesting. It consists of a close-wound spring of one-sixteenth-inch square section, wound so that the spring forms a thread.

Outside the spring are two semicircular metal containers that fit in the hole in the handle. A heavy steel ferrule goes over all. When the handle is screwed on the tang, the spring is expanded against the semicircular members, which in turn press against the wood. The ferrule prevents splitting, so that as the handle is screwed in, all the elements are jammed together tightly.



Double Approach Improves Your Hilltop Home



UNUSUAL effects in landscape decoration have been obtained for a California hilltop house by a double approach. The front yard is terraced, with four rises in all. On each of these are two series of steps, one on each side of the lot.

From the top of the bottom flight of steps to the bottom of the second flight

is a six-foot concrete walk. Identical concrete work is continued to the tops of the third flight, from which point the walk continues to the center and unites. A single flight of steps leads from this point to the porch.

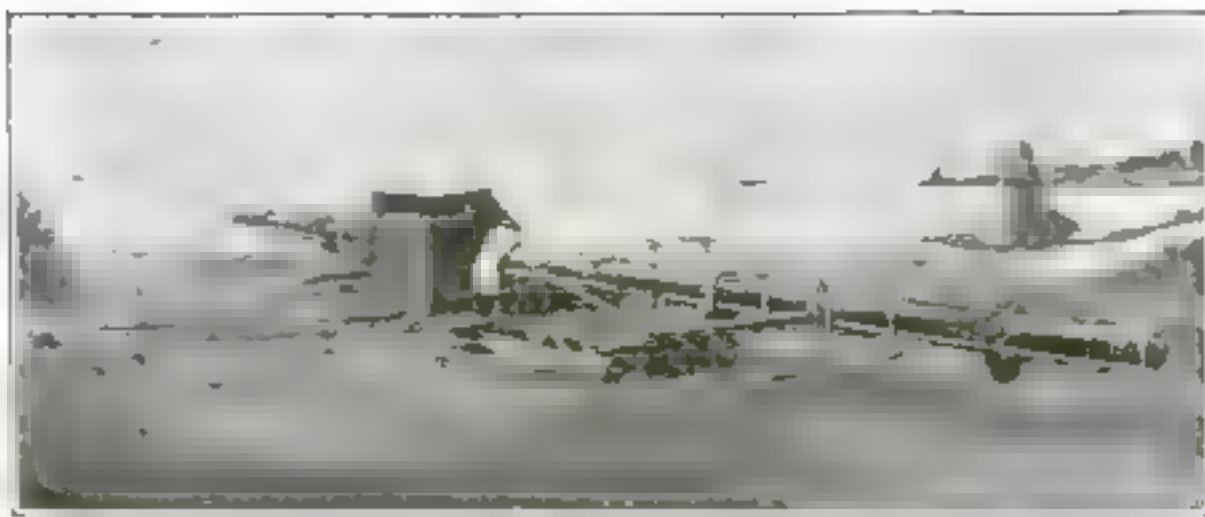
The effect concentrates the attention on the ground floor pergola, which is the feature of the architectural scheme.

EXPERIMENTS have proved that it is possible to change the color of certain precious stones by the action of radium.

Huge Range Finder "Spots" Objects at 22 Miles

A GIGANTIC range finder 100 feet long, recently constructed in England, will accurately judge the distance of any object up to 22 miles away. It consists of a long tube like a double horizontal telescope, which swings on a circular track to face in any direction. The instrument will be used for coast defence.

The operation of a range finder is based on the automatic solution of a right-angled triangle—instantaneous surveying in which the distance required is the height of a tri-



The new range finder, a double telescope, consists of a tube 100 feet long swinging on a circular track

angle of which the baseline, represented by the length of the instrument, is known. The longer the baseline, the more accu-

are determined. This solves the triangle, and to save time in giving the range, the angle is expressed in terms of distance.

rate will be the result

Two mirrors, one in each end of the tube, reflect a double image on the object glass, and the observer moves the azimuth wheels until these coincide. The range is then read directly from a scale on the wheels. By bringing the images together, the angles made by lines of sight converging from the ends of the instrument upon the object

What Do You Want to Know?

Ask Us About Your Radio Problems

Hydrogen the Best Lifter

Which gas has the greatest lifting power?

Hydrogen is the lightest gas known and has therefore the greatest lifting power.

Liquid Air Refrigeration

Why has not liquid air been adapted for use as a means of refrigeration?

Due to the expense of preparing liquid air and also to the fact that the temperature obtained is far below that required for the general purposes of refrigeration it cannot be used industrially and domestically for refrigeration. It is used, however, in surgical operations where very low temperatures are required.

An Automobile Handbook

Is there any book or list that gives complete information regarding specifications, prices, equipment, etc., of passenger and commercial automobiles?

The Handbook of Automobiles—1922 edition, published by the National Automobile Chamber of Commerce, 350 Madison Ave., New York City, contains complete information on the above subjects and also includes pictures of the cars. If you want particular information regarding any make, we shall be glad to give you such information.

Best Position for Aerial

In erecting a one-wire aerial, what is the best position of the aerial in order to get best results?

The length of the aerial should extend in the direction of the station or stations you want to hear best and the lead in should be taken from the end nearest these stations.

What the Grid Leak Does

What is the function of the grid leak?

When placed around the grid condenser it allows the excess negative charges stored up in the grid to leak off after the passage of each train of oscillations.

The Electric Needle Myth

I have heard that by the use of the electric needle, the bottoms of bottles containing liquor or valuable trademarked genuine drugs can be removed and inferior articles substituted. Can

this really be done, and if so what is the method used?

The old electric needle story that went the rounds is pure "bunk." Glass cannot be melted nor can the bottoms of the bottle be removed with the electric needle for the very sufficient reason that glass is for all practical purposes a non-conductor of electricity.

Height of Antenna

What effect has the height of an antenna upon the range of a radio station?

Usually the higher the antenna, the greater will be the range, but this rule does not apply in all cases.

Tightening the Coupling

What is the effect of tightening the coupling of a loose coupler on a radio receiver?

It makes the receiver responsive to a wide range of wave lengths without delicate adjustment of the tuning elements, because it increases the damping of the receiver as a whole. Tight coupling is not to be used when many stations are sending on approximately the same wave length, but it is useful when the chances of interference are not great.

High Resistance in Phones

Why are the windings of head telephones for radio work of high resistance?

The magnetizing force of any current-carrying coil depends on the number of ampere turns. Hence, to get the loudest response in a telephone from the very weak signals, it is necessary to use many hundreds of turns of wire and, due to the limited space, very small insulated wire must be used. The smaller the wire, the greater the resistance, which accounts for the fact that all sensitive telephones are of very high resistance (1500 to 3000 ohms).

EVERY reasonable specific query in the field of general science addressed to the Information Department will receive a prompt reply.

While lengthy studies cannot be given to complicated questions involving extensive research or experimentation, this department aims to let of maximum service in furnishing information as to what books or other sources may contain answers to these questions. Legal and medical queries cannot be answered.

A stamped addressed envelope must accompany each question, but the writer's name will not be published if he so requests. Address: the Information Office, Popular Science Monthly, 233 West 39th Street, New York City.



Prisoner Wearing Metal Boot Can't Escape

DANGEROUS criminals, shackled with a metal "Oregon" boot, have little chance to escape during long railway journeys. The boot, a modern adaptation of the old-fashioned ball and chain, consists of a steel framework fitting over the shoe, with a 60-pound collar above the ankle.

The prisoner who wears it can walk slowly with a fair degree of comfort, but should he attempt to run, or move quickly, the heavy weight will break his leg.

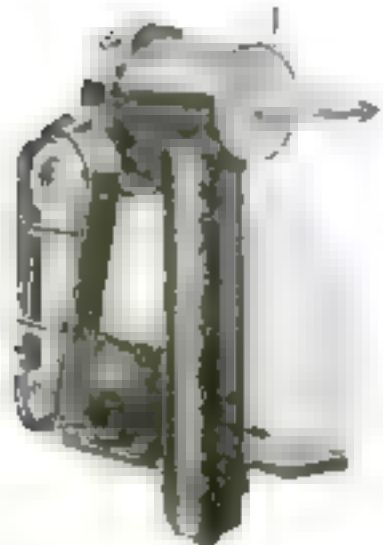
Water Filled Rollers Used in Road Construction



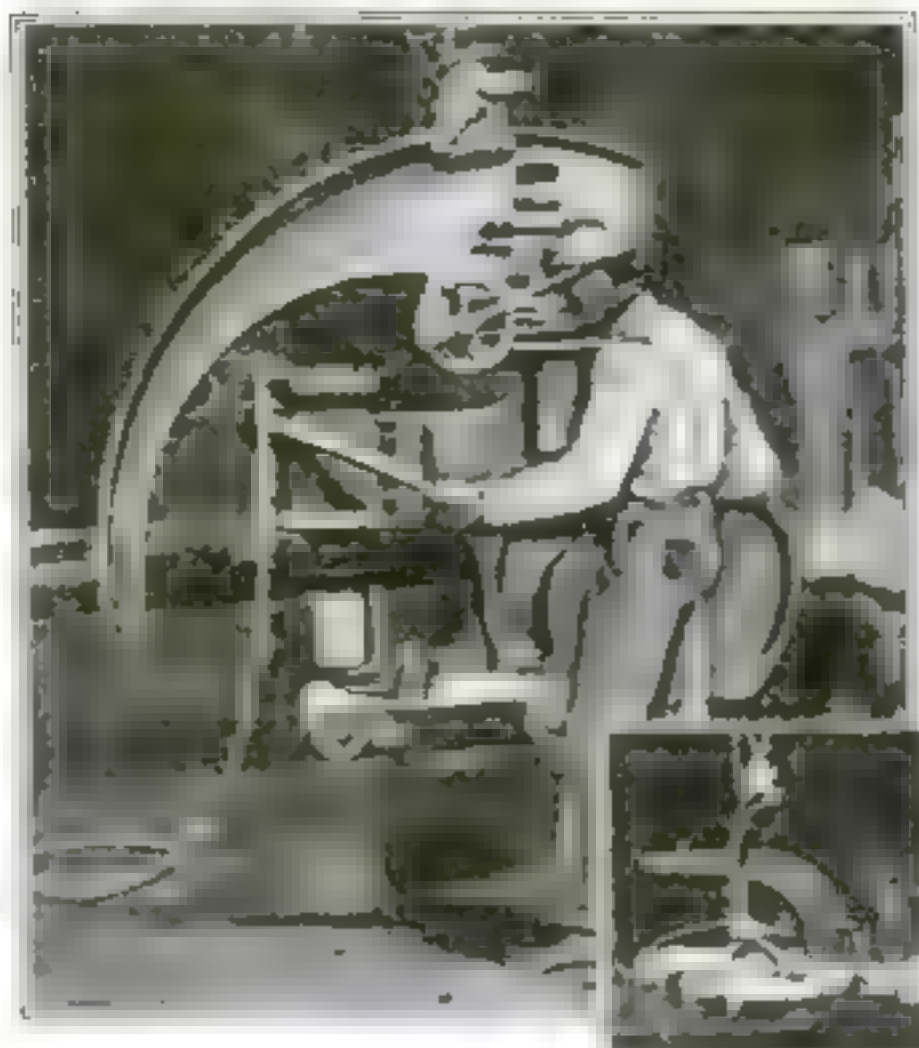
WATER ballasted rollers, first invented for use in small gardens, have recently made their appearance for road construction use. In a new English model, both the front and rear wheels consist of heavy steel tanks. By admitting the proper amount of water, the pressure on the road may be varied to a maximum of 2½ tons. This enables one roller to be used for all kinds of material and construction.

New Pressure Riveter Works at Any Angle

*Other Improved Machines and Tools
Described in Photos*



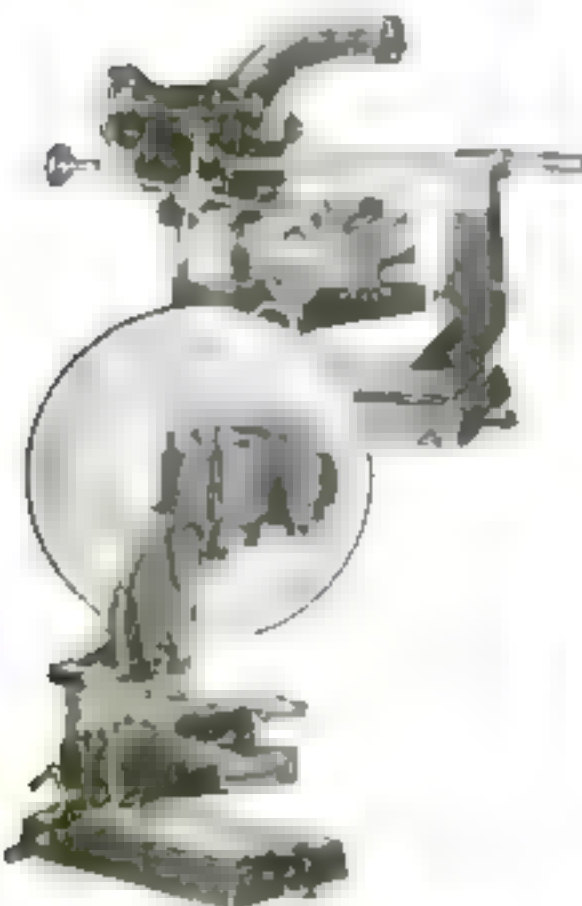
Replacing hand reaming methods, the compact reamer machine shown above is driven by a one sixth horse-power electric motor connected with any light socket. The gearing is so designed that the power will handle reamers as large as $1\frac{1}{4}$ inch



The latest development in riveting machines, a new type of machine designed for the production of rivets. The machine shown above is capable of producing rivets of all sizes and shapes, and is designed for the production of rivets of all sizes and shapes.



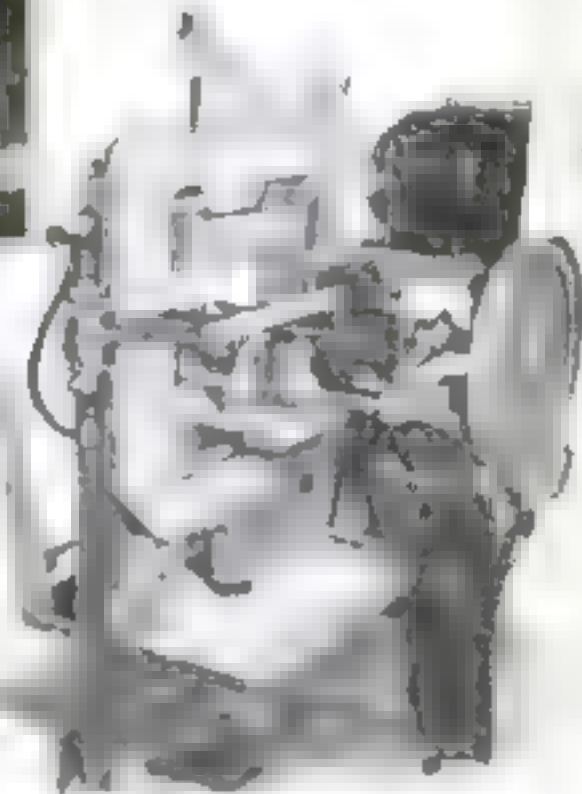
This type of circular saw blade gives the user the most efficient cutting action. The blade is designed to cut through any material, and is capable of cutting through any material. The blade is designed to cut through any material, and is capable of cutting through any material.



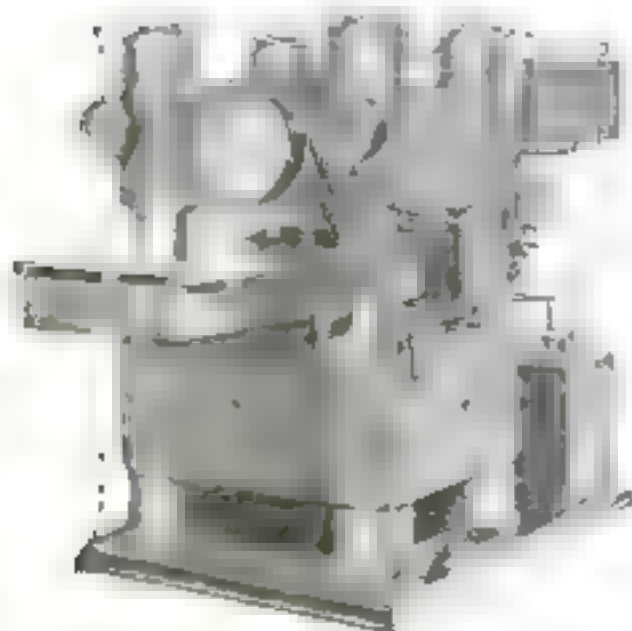
Turning, milling, and drilling at any angle may be done with this combination machine. The changes in position are made possible by the quadrant arm.



With this gage, the user can measure the thickness of any material, and is capable of measuring the thickness of any material. The gage is designed to measure the thickness of any material, and is capable of measuring the thickness of any material.



In this new type of shaping saw the removable blade is set in a frame that is moved back and forth by an eccentric rod driven by an electric motor. It is easily adjusted for inside cutting and may be used for a great variety of metal work.

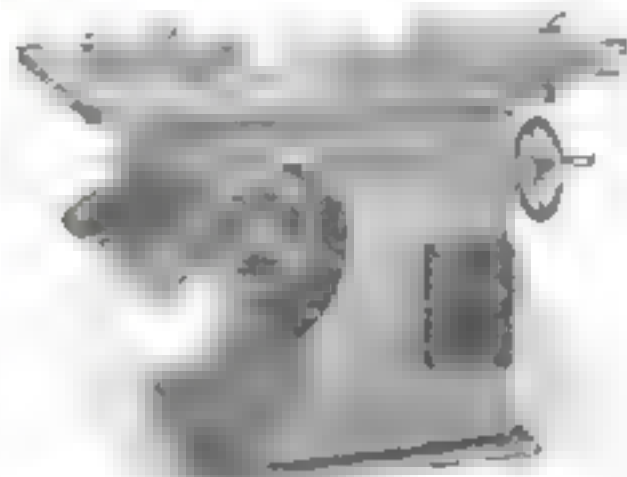


The lead molding press above was designed for the Claybourn process of solidifying electroplates at 1300 pounds pressure the square inch.



Much time may be saved by the use of this gage, which shows on the dial plus or minus deviations as small as .002 of an inch from the standard size.

AS a special service to readers, the Editor will be glad to supply names and addresses of manufacturers of devices mentioned in POPULAR SCIENCE MONTHLY.



Both the circular saw and the motor are attached to a tilting base, which permits setting the plane of the saw to any angle.

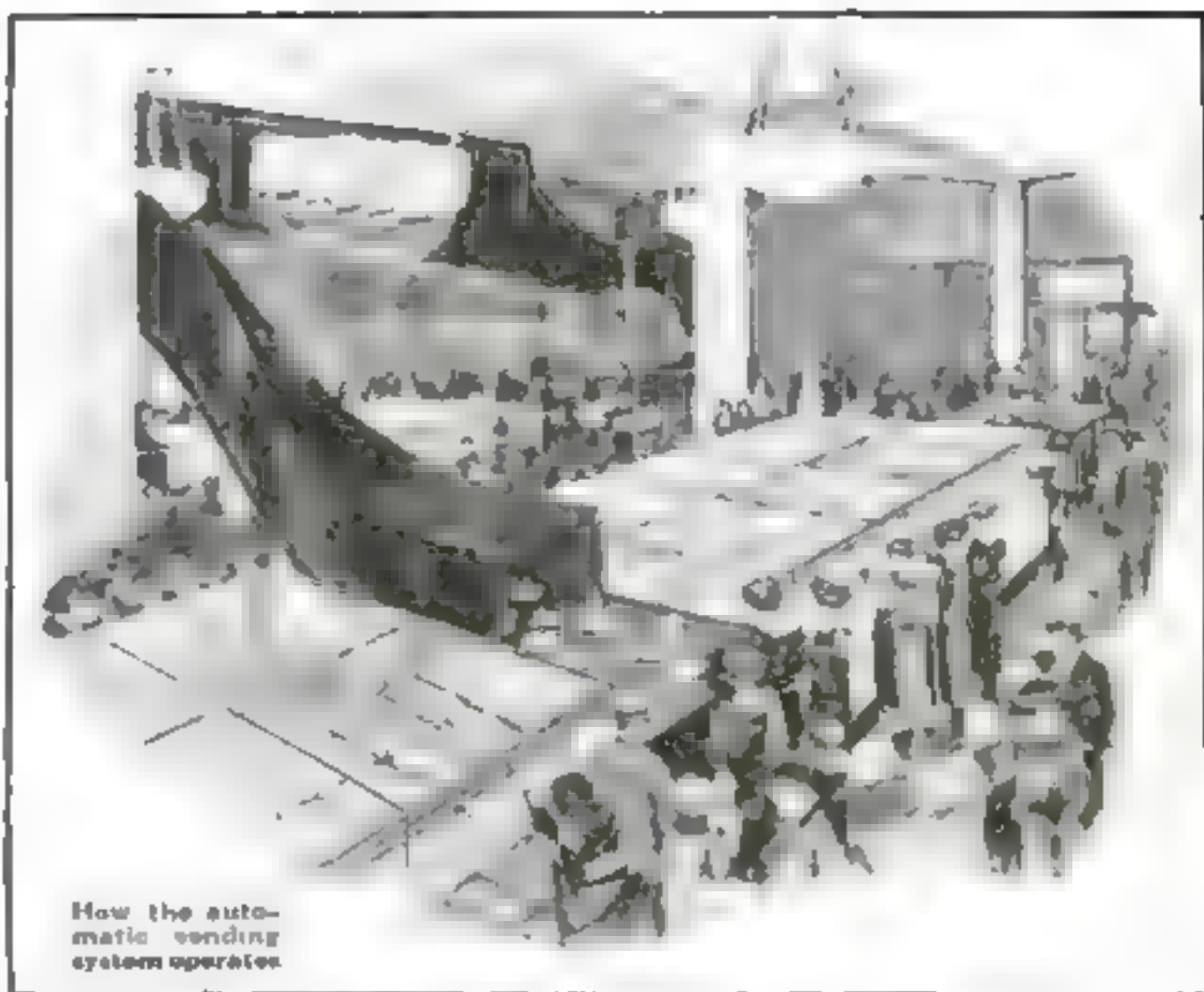
Chutes Deliver Goods in Pushbutton Store

A DEPARTMENT store without floor-walkers or saleswomen, and in which customers make their own transactions by a system of pushbuttons, becomes a possibility as the result of the recent invention of an automatic vending system for stores.

The system comprises a series of bins in an upstairs stockroom, where merchandise is stored in compartments, and metal chutes connecting the bins with counters adjacent to the display cases on the sales floors. On each display case is a row of buttons—a button for each kind of merchandise—connected electrically with the corresponding stockbin. The purchaser simply pushes a button to get delivery of the article desired. Payment for all articles received from bins is made at the cashier's cage.

Using the "Logarithmic Curve"

An interesting feature of this system is the "logarithmic curve" that is incorporated near the base of each delivery chute in order to slow up the descending articles to a moderate and uniform speed. Just as in the case of bicycle racers rounding a banked curve—the fastest moving objects go to the highest part of the curve, incur greatest resistance, and consequently are slowed down as desired.



Crewless Cars to Haul Freight through Intercity Tubes

AUTOMATICALLY controlled freight cars shooting through tubes under the Hudson River from New Jersey to Manhattan at the rate of 14 miles an hour are proposed as the basic principle of the freight handling scheme of the Port Development Commission of New York Harbor.

These cars, with self-contained motors operated from overhead trolleys, will be loaded on one side of the river and started

outward with their loads. Tripping switches placed alongside the track will automatically hold their speed to three feet a second until the outskirts of the yard are reached. Then the speed will be increased to 10 feet a second, and, finally, as they approach the mouths of the tunnel, the third and last tripping mechanism will throw the motors into high and the journey under the river bed will be made at the rate of 1200 feet a minute. Collisions will be made impossible by automatically energizing a section of track before and behind each train.

On arriving at the opposite side, other triggers will gradually slow down the loaded cars and finally bring them to a halt, applying the brakes at a predetermined speed. Brakemen walking beside the cars will then control their movements in shunting from

one track to another in the terminal.

To facilitate the movement of the loaded cars from the incoming tracks at the terminal warehouses to the floors where the cars will be unloaded and loaded, a series of electric elevators is planned. These elevators will drop to the lowest level, pick up the car and its load, and lift it to the main floor. The car will be pushed off the elevator and across the building to a shuttle elevator running between any of the floors.

The elevator scheme may be used as a traffic system incorporating incoming and outgoing cars. The main elevator handles only the incoming and outgoing cars, while the local elevator carries the cars up or down to the desired floor. This method is essential because of the constantly arriving cars and the necessity for keeping



At the Manhattan terminal warehouse of the proposed automatic freight transfer system under the Hudson River, loaded incoming cars, controlled by tripping switches, will be lifted bodily to the upper floors by electric elevators, as illustrated above.

A Place for Everything in New Auto Body

Other News of Motor World in Photographs



With the ingenuity and economy of a modern apartment, spaces are provided in this new type automobile body for stowing away suitcases, toolboxes, trunks, and other baggage in inconspicuous places. Note the runningboard closet and the cupboard under the "spare"



This new oil gage enables the Ford driver to learn by a glance at the dashboard indicator how much oil is left in the well



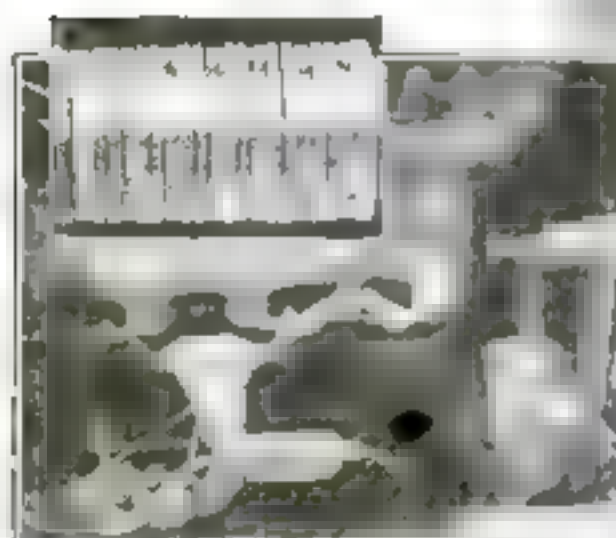
Driven by an electric motor, this machine, when clamped to the cylinder block rebore the cylinder on which it is centered



The clutch governor shown above operated by pressing down the clutch pedal, automatically prevents the friction clutch from taking hold too suddenly



This jack, constructed on the cantilever principle, is operated by a worm meshing with the gear sector that forms the base of the lifting arm



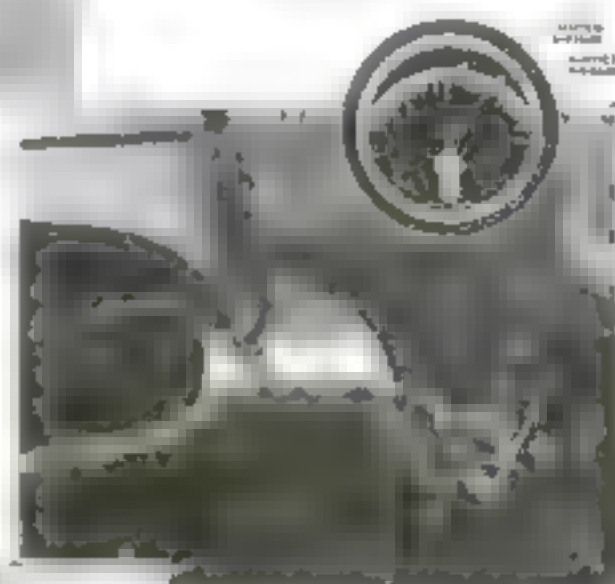
When this combination disk lock is inserted in the gasoline feed line of an automobile or a motor boat, the gasoline supply can be "locked up"



The fender brace for Ford cars, shown below, not only adds to the appearance of the car but prevents the front fenders from rattling



Whether the bearing is large or small, the cutting blade of this tool is always centered on the crankshaft



A new heat indicator for automobile engines, operated by a thermo-static unit on the engine block, tells the driver whether the temperature is at efficiency point

© Kevittone

Electric Grocery Scales Prevent Overweight



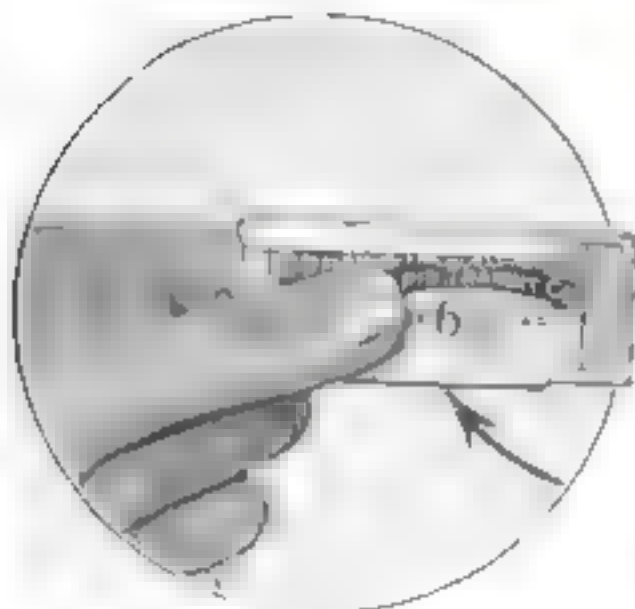
ELECTRIC grocery scales that automatically shut off produce falling from the bins into the scale pan when the exact weight is reached now prevent the slight overweight that may represent the entire profit on the sale. In the new device, the weights are set as in the ordinary scale, but the balance, as it falls, closes an overhead cut-off connected with the bin.



How scales operate cut-off

Under each bin outlet is an electrical connection. The scale slides along a glass topped counter, and when it presses against a copper bus-bar running at the back of the counter, the connection is closed.

Car Ticket Holder Saves Commuter Worry



ONE of the troubles of the harassed commuter evaporates as soon as he secures a new type of holder for his car or ferry tickets. At last he can buy strip tickets enough for a week without having them lost or soiled in his pocket. A single ticket can be pushed out by the thumb for the ticket taker.

Truck Draws Power from Trolley Wire

A STORAGE battery truck that draws its motive power from a trolley wire has been developed by a street car company in England.

In making long hauls into the country it was found that the ordinary capacity of the battery was insufficient. Now each truck carries two poles with contacts on the ends. One pole grasps the trolley wire and the other slides along the rail, thus completing the circuit.

The charging current from the trolley is greater than that demanded by the truck, so that when it is desired to detour to make deliveries the poles are lifted in and the truck is driven from the current stored in the batteries. This current is sufficient for a run of from 10 to 15 miles. Another advantage of this lorry is that it can make



The truck carries one pole that reaches to the trolley wire and another that slides along the track

short detours in congested districts or pass around stalled trolley cars. It is equipped with solid rubber tires.

Steam Chopper Mangles Tough Redwood Bark

BECAUSE redwood bark, used in making certain kinds of paper pulp, is so tough that it cannot be sawed, a San Francisco company has devised a steam operated chopper that effectually mangles the bark fibers into shreds.

The chopper consists of two axes placed at right angles to each other. The operator controls the up and down movements of the chopper as well as its rotating motion that changes the striking position of the blades.

Redwood bark is practically fire, acid, and rot proof, and nearly destruction proof.



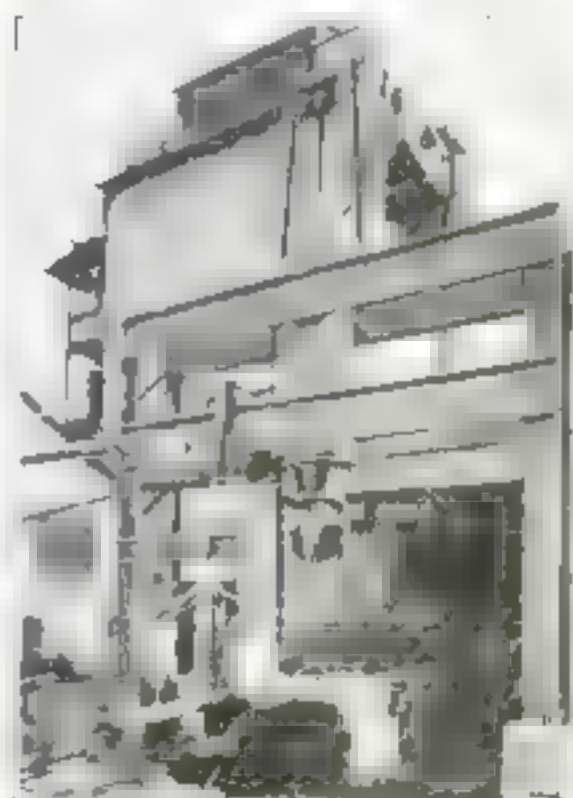
Sound Amplifier for Deaf Is Hidden in Cane

AN EXTREMELY sensitive phone receiver hidden away in the knob of a walking stick is one of the latest sound amplifiers for the use of the deaf. The coils for tuning in the sounds and adjusting their intensity are stored in the stock of the cane along with the batteries for operating the amplifiers.

In designing the amplifiers, Maximilian Weil, the inventor, employed a principle similar to that of radio loudspeakers.

Old Floor Is Gold Mine

FOR a cheap pine floor laid 10 years ago in his repair department, a Detroit jeweler was recently paid \$1000 by a New York refining firm on the assumption that the floor contains at least this amount in gold sweepings.



Two ax blades set at right angles change position by rotation with every stroke of the chopper

Cranes Wreck Transmission Towers in Tests

DELIBERATELY pulling down electric transmission towers by means of a gigantic crane, engineers of the Canadian Bridge Company are now able to calculate the strength of these structures within five per cent of accuracy.

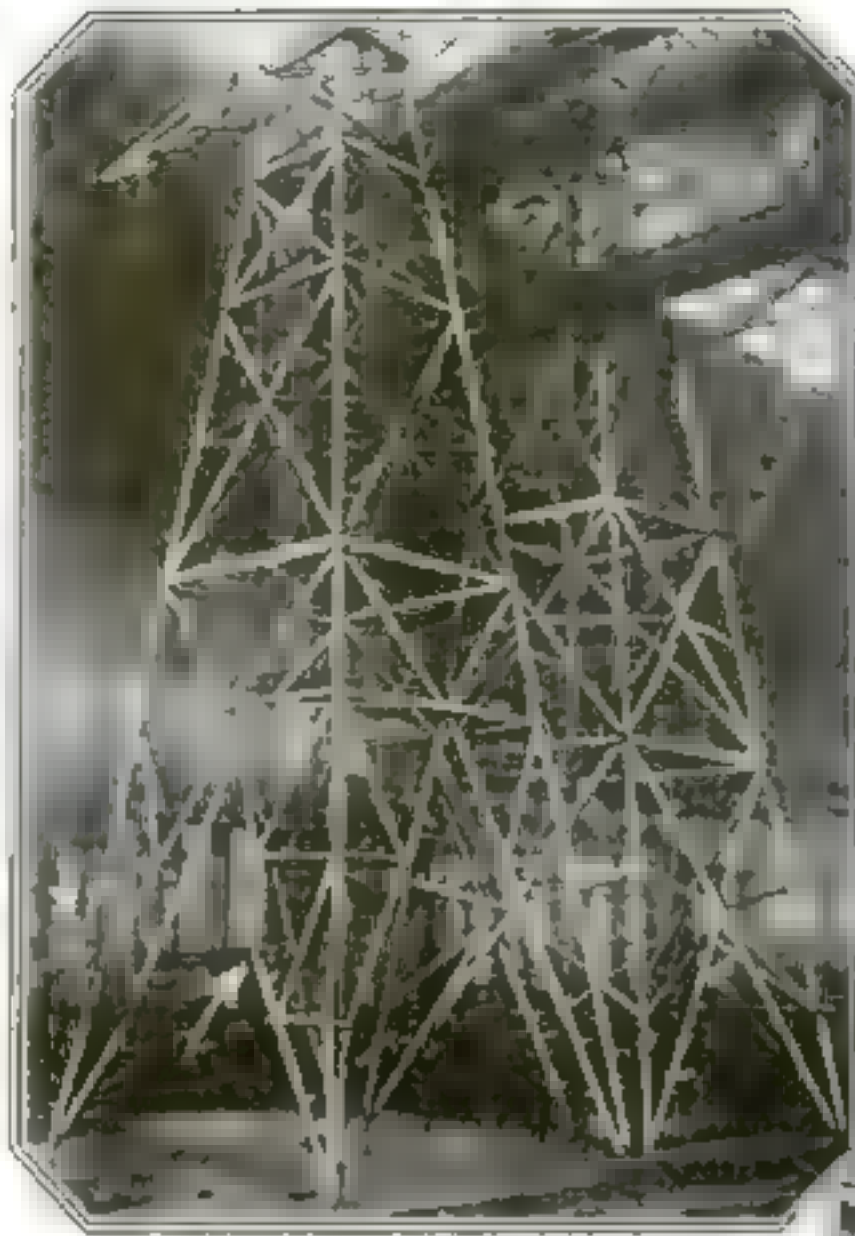
In the past such towers were known as "indeterminate" structures—that is, it was considered impossible to calculate their strength as the strength of a bridge is calculated. In consequence, they were built far stronger than was necessary.

Tremendous Strains Applied

The new pulling down tests are continued until the steel towers break, although this may require more than twice their guaranteed load. Some of these towers are 80 feet high, and designed to resist a strain of 30 tons.

For the purposes of the tests, the towers are erected on the testing ground. Where the wires would be attached in actual service, cables are secured to the tower and led to a 40-ton traveling crane. The strain is applied slowly, and the force exerted is measured by dynamometers to determine the tension at which the first signs of failure occur, and later, the point at which the framework of the tower actually bends or breaks.

The attachment of the weights and cables for these tests is rather



Arrows above point to typical buckling failures in the steelwork of a tested transmission tower, caused by strains deliberately applied.

complicated, as the towers must be able to withstand not only the weight of the wires, but also the weight of the wind. The wind pressure on the tower is a factor in the design, and the wind pressure on the wires is a factor in the design. The wind pressure on the tower is a factor in the design, and the wind pressure on the wires is a factor in the design.

The load on the towers is applied by cables attached to the cross arms where wires would be attached in actual service, as shown below.



Alaska Indians Copyright Totem Poles by "Unwritten Law"

TOTEM poles carved by Alaskan Indians are copyrighted—not by law, of course, but by tribal custom that decrees that any man who copies the figures on the totem of another, even in the smallest detail, shall be severely punished.

Practically every totem pole in Alaska

has a symbol represented by the eagle or the raven, yet these birds are never exactly duplicated. It is this unwritten law that accounts for the wide diversity of the poles and the originality of their design.

Only one Indian able to carve an elaborate totem remains, it is said, and in conse-

quence the history of the tribes is no longer being "written" in this strange way. The poles served a double purpose—as grave-stones and as historical records of a tribe, family, or individual. The taller poles often recorded marriages and other important events for several generations. They were epitaphs in wood, prepared during the individual's lifetime.

Because of the general decline in the observance of native customs throughout Alaska, totem poles are no longer erected and the severe weather of the Far North is rapidly destroying the few that remain.

The weird combination of birds and beasts always seen on these monuments is due to the fact that every Indian selected a certain animal as his "totem" or guardian. This animal, which might be a raven, eagle, hawk, or bear, he never killed nor ate; and in return he expected the creature to protect him from danger.

Significance of Eagle and Raven

The explanation of the constant repetition of the eagle and raven on the poles is that although there are 12 tribes of Alaskan Indians, there are only two "families"—the Eagles and the Ravens. It was an ironclad rule that the father of every family must belong to one of these clans, and the mother to the other. Though no relationship might exist, all "Eagles" were brothers. Every marriage was recorded by carving the clan sign of the mother on the pole. All the other personal carvings, recording a successful hunt or a prosperous year, were grouped around this sign.



At the left—Close-up of totem pole at Wainwright, Alaska. Center—One of the tallest and most elaborate of the "Eagle" totems at Alert Bay, B. C. At right—A famous pole of the family of Chief Kiatwagila at Alert Bay.

The Truth about Lightning

What We Have Learned about Its Power and Pranks

By Dr. Charles P. Steinmetz

Chief Consulting Engineer, General Electric Co.

LIGHTNING this summer is more interesting than ever to some million and a half Americans who own radio sets. While they haven't worried about the effect of lightning on telephone or light wires, many owners of radio outfits have hauled down their aerials rather than run a risk.

Because the phenomenon itself is so fascinating, and because of the wide-spread uncertainty concerning the possible dangers of radio equipment during thunder storms, **POPULAR SCIENCE MONTHLY** asked Dr. Charles P. Steinmetz, the creator of artificial lightning, the modern Jove who handles thunderbolts of his own making—to explain just what lightning is, how it acts, and the best methods of protecting the radio outfit from its pranks.

LIGHTNING has always been the most mysterious and most terrifying of all phenomena of nature. Benjamin Franklin solved the mystery by bringing the lightning down from the clouds in his kite experiment, demonstrating that lightning is a discharge of electricity like that in our electric machines, only vastly more powerful.

Contrary to the general opinion, a lightning flash between the clouds and the earth is a comparatively rare occurrence; by far the greater number of flashes take place between one cloud and another. For this reason the opportunities of studying the phenomena are few in number, and this fact, added to the short duration of the action and the consequent destruction so frequently accompanying it, has greatly hampered scientists in their search for light on lightning.

Only in the past few years, with the advance of electric engineering, has science become able to understand more fully and explain the electrical phenomena of the thunder storm. Now we can calculate the voltage and the energy of the lightning flash, and finally we have been able to reproduce lightning experimentally in our laboratory.

Where does the electricity of the thunder cloud come from, and what causes it to rise to enormous values? Incandescent bodies, like the sun, continuously send out negative electricity, and so become positively electrified. In contrast with them, dark bodies like the earth become negatively charged. The water vapors, condensing as raindrops in the clouds, therefore have a small electric



From Drops of Vapor to a Lightning Flash

THE story of lightning, as told pictorially above, begins with the white-hot sun, which continuously sends out negative electricity, charging the earth. Heated water vapors, having risen and condensed in clouds, have small electric charges induced on them by the earth's electric field. When a myriad of tiny vapor particles gather by successive combinations into a large raindrop, as illustrated in the inset, their small charges are crowded in one

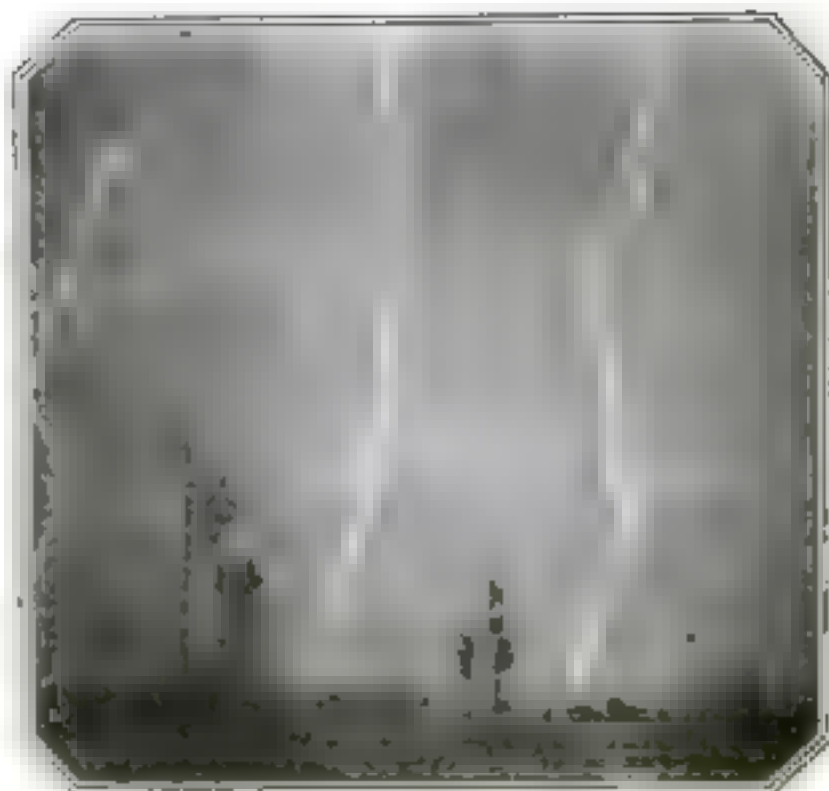
charge, due to the electric field of the earth. When, then, hundreds and thousands of minute drops conglomerate to a large raindrop, the minute charges of all the small drops collect on the one large drop. But the capacity of the large drop is very much smaller than the capacity of all the small drops together and the electricity on the large drop thus is crowded together; that is, under higher pressure. By conglomeration of many small moisture particles into one large raindrop, the voltage rises until it reaches values sufficient to jump through space as a lightning flash.

drop, the capacity of which is less than the combined capacity of the tiny drops. For that reason the electric pressure or voltage on the larger drop is greatly increased. When the voltage of combining drops exceeds the limit of electric pressure that the air can stand, the charge 'bursts' its bounds and leaps in a flash from cloud to cloud or from cloud to earth wherever the electrical tension is less. Dark clouds contain the heaviest electrical charge

ascending collection of raindrops until it comes near enough to the earth to break down the resistance of the air. The speed of the electricity is, of course, infinitely greater than that of the falling raindrops, which arrive an appreciable length of time after the flash of lightning.

There are really three things that make up the lightning flash—the voltage of the thunder cloud, the current in the discharge, and the length of time of the discharge. All of these three quantities multiplied together give the amount of energy.

Experience shows that on low-voltage



Spectacular flashes of lightning across the sky, such as these, usually occur between clouds. Flashes between the clouds and the earth—occasions when lightning 'strikes'—are comparatively rare.

You have noticed, no doubt, that rain clouds are dark—sometimes black—shading off to lighter portions. The dark sections appear darker than the rest because they contain more moisture. Hence they contain a greater amount of electricity than the lighter portions and are under heavier electric pressure or voltage. These clouds are the ones that contain the multitude of small drops with their high tension electricity that ultimately will jump from one cloud to another cloud with a brilliant, awe-inspiring flash.

It is a common occurrence that a heavy downpour of rain follows a lightning flash. This is probably due to the fact that a large amount of electricity is carried down toward the earth by the de-

electric circuits the effects of lightning are irresistible, while very high voltage lines, such as those of 100,000 volts and more that are now transmitting current over the country, possess an appreciable immunity from lightning interference. From the known insulation of these circuits scientists have figured that the amount of electric pressure in a lightning flash is in the magnitude of 50,000,000 volts.

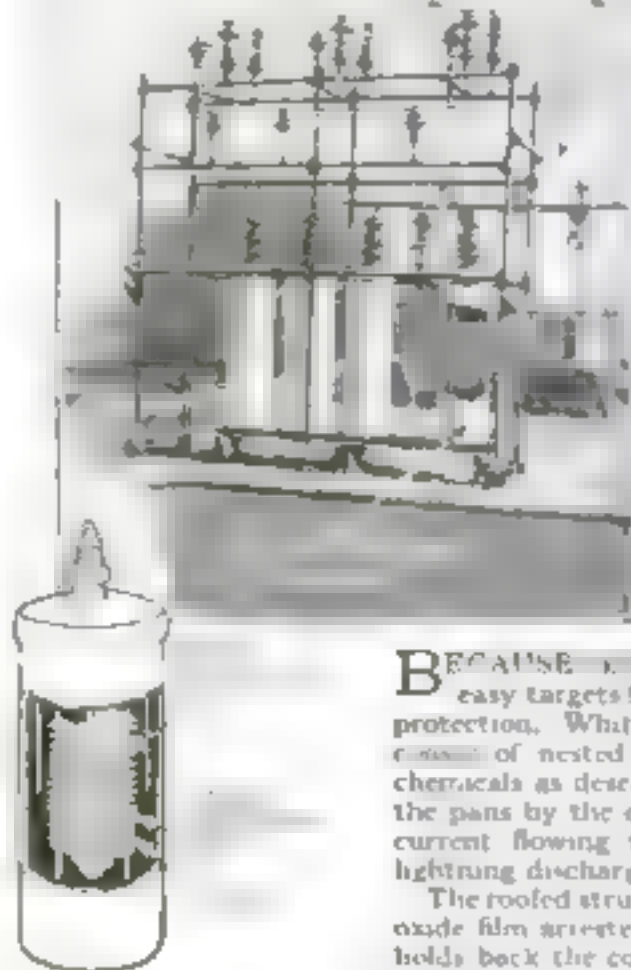
To estimate accurately the current or number of amperes in a flash is much more difficult; for we must know the conductivity of the air in the path of the discharge and the diameter of the bolt. Neither of these factors is known, but by choosing a reasonable figure for each, we find that the current in a flash should amount to thousands of amperes—perhaps 10,000 more or less—with a duration probably of about 0.001 seconds.

The Eye Remembers

It is an interesting fact that while a lightning flash in reality travels too fast for the eye to perceive its trail, all of us have a vivid image of the flash when it occurs. This is due to the persistence of vision of the eye. Any image that the eye sees, it retains for about one tenth of a second. Thus no matter how rapid the flash may be, the eye gives it the same duration.

Shrewd individuals are always interested in figuring out what they believe to be a tremendous amount of power that goes to waste in lightning flashes. As a matter of fact, all the energy in any of the terrific

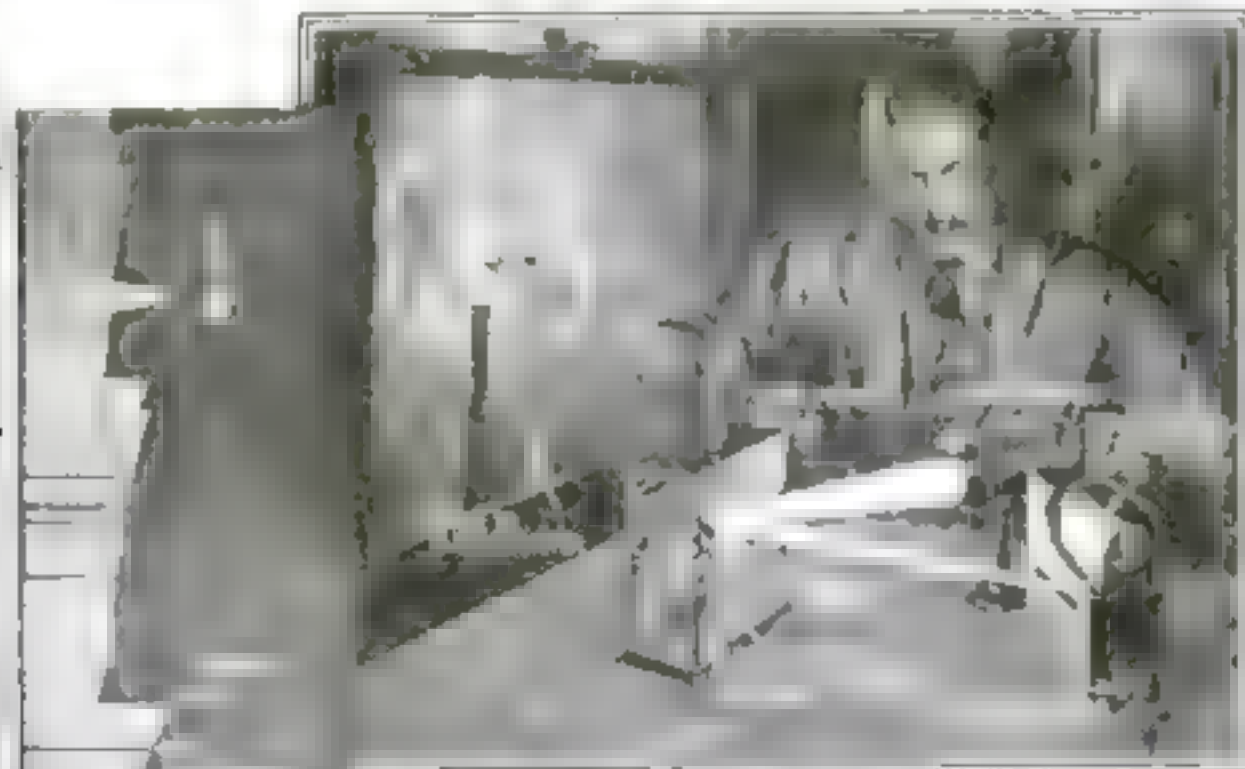
At the right are the elements of an oxide film arrester. By means of this the lightning film between the metal disks the arrester is insulated to any voltage.



BECAUSE lightning cross country transmission lines are easy targets for lightning, elaborate equipment is used for protection. White cylinders in the equipment above—the left—consist of nested aluminum pans separated by thin layers of chemicals as described in the inset. A thin film produced on the pans by the chemicals prevents passage of low potential current flowing through the transmission line, but allows lightning discharges to penetrate to the ground.

The roofed structures at the right house the newly developed oxide film arresters. A thin insulating film of special varnish holds back the common variety of current, but lightning and static break through to the ground.

How Science Measures the Energy in a Thunderbolt



The record of successive lightning flashes at left was made on sensitized paper by light reflected from a moving mirror in the measuring apparatus shown above.

the metal ball—and the other with the ground. A small mirror attached to the fiber of the swinging vane completes the apparatus.

Normally the aluminum vane hangs between the pairs of quadrants, but if a charge of electricity, no matter how small, is conducted to the proper pair of quadrants, the vane swings to one side. The amount of the swing will depend on the intensity of the charge. Finally, if a beam of light is directed to the swinging mirror at an angle, the reflected beam will change its direction when the mirror moves. The latitude of the beam can be recorded by focusing it on a strip of moving photographic paper.

The Energy of a Flash

The amount of energy in a flash was computed by measuring its distance away, the height of the initially charged cloud, and the change in the electrical field of the electrometer. Distance was easily determined by the interval between the lightning flash and the thunder peal, while the height of the cloud was computed by trigonometric means.

Professor Wilson computed the flow of energy in the average flash as 20 coulombs; the familiar 25-watt tungsten filament lamp passes 20 coulombs of current in $1\frac{1}{2}$ minutes.

Using figures obtained from the experiments with the metal ball and electrometer, the voltage of a lightning flash was estimated at one billion volts. On this basis the total energy in a single discharge would be 3700 horsepower hours, or sufficient to lift 500 tons to a distance of $1\frac{1}{4}$ miles above the earth's surface.

TWO hundred and eighty dollars a flash, representing enough energy to light a house for 10 years, is the value set upon a lightning storm by a British physicist, who obtained his figures from actual experiments conducted with appa-

ratus of his own design. His estimate is in sharp contrast to that of Doctor Steinhilber.

In investigating the current flow from lightning discharges, the physicist, C. T. R. Wilson, erected a pole in an open space near his laboratory and on the top of the pole placed a metal ball the measurements of which were accurately known. The ball was connected with a sensitive indicating device called an "electrometer." It consists of four fixed metal quadrants, arranged like a four-leaf clover, and an aluminum vane shaped like a two-bladed airplane propeller, which is suspended underneath the quadrants by a thin fiber. Opposite quadrants are connected electrically, forming two pairs, one of which is connected with the source of electricity—in this case

"ALL the energy in any of the terrific storms to which certain parts of the country are annually subjected would barely light a small community for an evening. A flash is worth about 70 cents."—DR. CHARLES P. STEINMETZ.

storms to which certain parts of the country are annually subjected would barely light a small community for an evening.

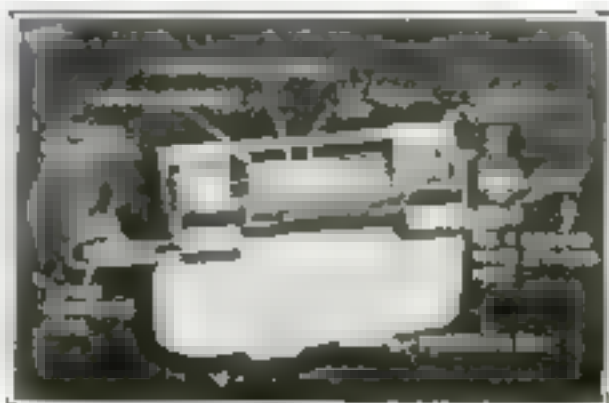
If we assume that the voltage of a lightning flash is 50,000,000, the current about 10,000 amperes, and that the flash lasts one 10 thousandth of a second, the energy would be equal to 18 horsepower, worth about 70 cents at the current rate of 5 cents a kilowatt hour.

The light from a lightning flash is startling, almost terrifying, at close range, but when resolved into actual figures it is not so imposing. The illumination from a flash is equal to about one foot candle-power. This is the equivalent of the light from an ordinary candle held a foot away from the object to be illuminated. It has been frequently noted that a room illuminated to this intensity is not materially brightened by an outside lightning flash, which leads us to believe that the unit of illumination in both instances is about the same.

Reducing a Flash to Figures

If we now assume that the flash lights up an area of two miles square or 100,000,000 square feet, then the total light becomes equivalent to 100,000,000 foot candles.

Just at present, because of the wide interest in radio affecting every homestead,



This compact lightning arrester for radio receiving stations consists of a short air gap in a vacuum. Since lightning and static are of high frequency and high potential, they prefer to jump the gap to the ground rather than enter the receiving apparatus. Potential of radio message waves is too low to leap the gap.

the problem of lightning protection is in every one's mind. Radio sets may be protected to the last degree with approved lightning arresters, but even so, there is no surety that the lightning discharge will follow the path laid out for it. Lightning is independent. In many instances of direct hits the bolt has seemed to shun the most natural means of ingress and exit and to have followed devious paths.

Two years ago when my camp on the Mohawk River, near Schenectady, N. Y.,

was struck by lightning, the peculiar antics of the discharge were everywhere evident. The bolt first hit a tree overhanging the camp, then leaped a gap to the camp, where it divided. One portion went to the ground through a post, from which large splinters were torn. The other branch shattered a window, entered on the camp's lightning circuit and there produced an oscillation, destroying some of the lamps while leaving others located between them untouched. The bolt then branched further, shattering and splintering several posts, a screen door, a bed, and a looking glass. The fragments of glass were scattered widely about the room.

How to Protect Yourself

The radio enthusiast can best protect himself, his home and his outfit from lightning by disconnecting the outfit during showers and arranging the ground wire so that it leads in as nearly a direct line as possible from aerial to ground. This layout would take care of any small charges induced in the antenna by local discharges.

There is no telling what pranks lightning will play on an aerial if it hits the aerial directly, but as this will occur but infrequently and perhaps not at all throughout the country, it is not a possibility to worry over.

Auto Motor Drives Switching Engine

SWITCHING engines with automobile motors and locomotive type transmissions, recently put in operation in the yards and shops of the Pacific Electric Railway Co., of Torrance, Calif., have proved cheaper than steam. Each of the novel engines is 22 feet long, weighs 22,000 pounds, and has a tractive pull of 3000 pounds.

A six-cylinder auto engine of 70 horsepower is the source of power. A friction disk clutch is employed, but from this point on the driving mechanism is

exactly similar to that of a steam engine. The power shaft leads to a jack shaft ending in a crank and pin, to which connecting rods are fixed to transmit the power to the driving wheels. The speeds are five and 10 miles an hour.



How an automobile type power unit is combined with locomotive type driving mechanism in the new switching engine. Inset shows the engine at work.

Are Most of Our Ills Caused by "Nerves"?

IF IT is true that at least 75 per cent of all the persons who apply to physicians are nervous patients, as has been asserted by many competent authorities, "Outwitting Our Nerves," a new book by Josephine A. Jackson, M.D., and Helen M. Salisbury, published by the Century Co., New York, should reach a wide circle of readers with a message of hope and much sound advice that will aid in the restoration of health.

The authors call it "A Primer of Psychotherapy," but this characterization, with its suggestion of technicality, should not deter any one from reading it. The book is a sane interpretation of Freudian principles, free from extravagant speculation and warped conceptions and written in language simple, direct, and convincing, without self-conscious striving for literary effect.

In the chapter entitled "The Drama of the Nerves," the authors give the following tersely worded summary of the subject under discussion:

"Disease may be caused by physical or by psychic forces. A 'nervous' disorder is not a physical but a psychic disease. It is caused not by lack of energy, but by misdirected energy; not by overwork or nerve depletion, but by misconception, emotional conflict, repressed instincts, and buried memories. Seventy-five per cent of all cases of ill health are due to psychic causes, to disjointed thinking rather than to a disjointed spine. Wherefore, let us learn to think right."

The author offers numerous practical, common sense suggestions for discovering the knots in harmful thinking and for ironing them out.

On the Crest of the Radio Wave!

By Jack Binns

America's First Wireless Hero and Most Famous Writer on Radio

Can Wired Wireless Change Radio Broadcasting?

How One Orchestra May Play to an Entire City

Jack Binns broadcasts monthly the essential news of radio to the readers of *Popular Science Monthly*

Another Young Radio Wizard—Big Problems that Need Solving

MAJOR-GENERAL GEORGE O. SQUIER, chief signal officer of the United States Army, apparently threw a monkey-wrench into the general machinery of radio broadcasting, a short time ago, when he gave a demonstration in Washington of his "wired wireless" system, as applied to music transmission. His success immediately threw the electric light people into paroxysms of joy, and correspondingly caused the new radio fans a lot of perplexity and wonderment.

The Romance Would Be Lost

The feeling of the electric light people was well illustrated by the tenor of the articles in their trade publications. They did not hesitate to declare that the system would put the entire broadcasting situation into their hands, and solve the problem of paying for broadcasting by permitting them to establish a toll system. Will it?

That is the question that has perplexed the radio fan, especially the one who has invested in an elaborate receiving set. I have discussed it pretty generally with some of the most famous men identified with the development of radio. They all seem to agree with me in the belief that the romance of feeling about through

the ether, picking up Pittsburgh, or Chicago, or some other station, as your fancy and skill dictate, is one of the prime attractions of the present broadcasting system. Wired wireless broadcasting would kill this chief pleasure of radio.

I have yet to meet a radio fan who is content to sit back and just enjoy the music scheduled by one particular broadcasting station. He wants to monkey around with the controls, and get a sample of everything that is going in the ether that night. He wants to try for the far-distant stations. When he gets one, he is tickled pink. Wired wireless, because it would restrict us to the program from some one local station—an electric light generating

station at that!—would take half the joy out of our evenings of radio adventure.

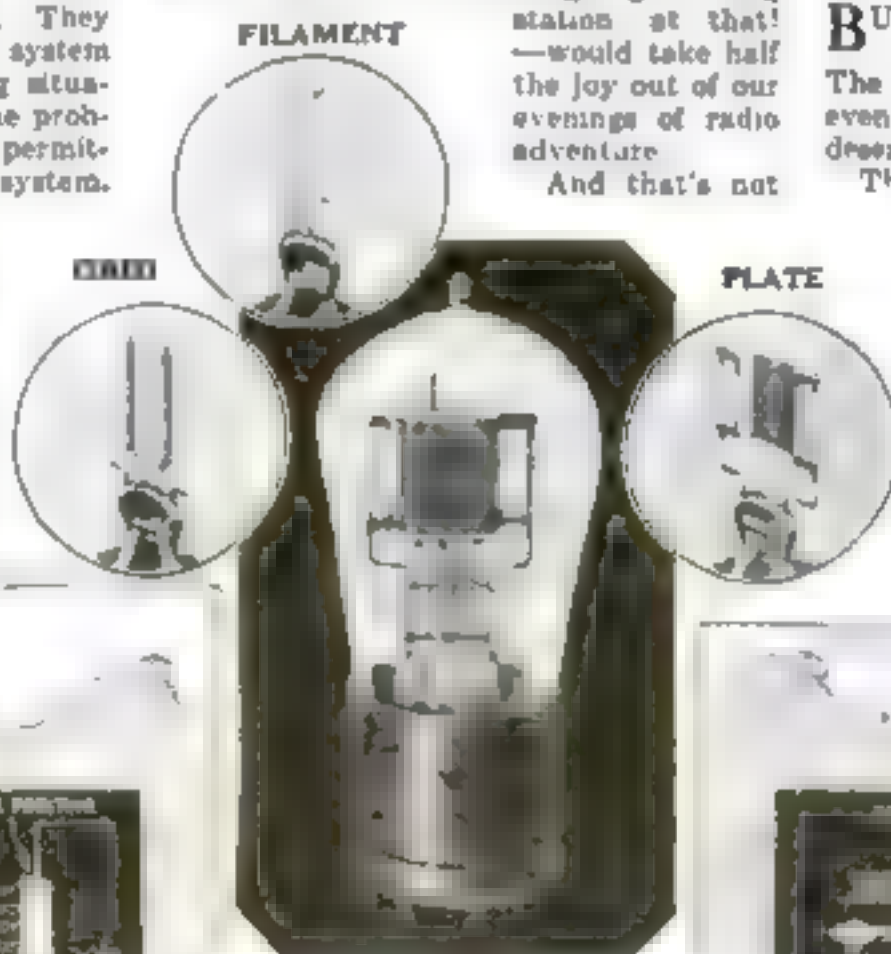
And that's not all. How are you going to apply wired wireless to the rural communities? Half the people in this country live in rural districts.

Radio's great destiny is to bring news, music, lectures, and every variety of entertainment and instruction to these rural communities, breaking down one of the last barriers that have kept the advantages of city life away from the country dweller. Wireless broadcasting will do this cheaply, and in fascinating fashion. "Wired broadcasting" could only do it at great expense.

How Wired Radio Works

BUT what is this "wired wireless" system, anyway? How does it work? The answer is simple enough in its way, even if the invention is so marvelous as to deserve all the recent talk it has created.

The system was developed by General Squier, chiefly to meet certain conditions that developed during the war. It gets its name because of the fact that instruments usually connected solely with wireless work are applied to wire circuits running between two points. By its use it is possible to simultaneously send upward of 40 different telegraph messages on one wire between two cities. No one of these messages interferes



Above is a typical radio vacuum tube, with its three important parts: filament, grid and plate. When assembled, the plate encloses the other two parts.

THESE diagrams explain the working of a vacuum tube and its parts—the filament, plate, and grid. The filament, heated by electric current from the battery, is like a gun, continually bombarding the plate with little electrons, which must pass through the grid to reach the plate. The grid acts as a spasmodic shield. When a radio wave in its positive phase strikes the aerial, passing to the grid and making it positive, the negative electrons are allowed free course to pass through the grid to the plate, as illustrated above.

WHEN the negative phase of the radio wave reaches the aerial and the grid becomes negative, the effect is as if a screen were lowered between filament and plate, completely cutting off the volley of negative electrons. The plate is connected through a dry battery with the head phones. Every time the electrons are allowed to pass from filament to plate, they produce an impulse in the phones. Since these impulses are controlled through the grid by the wireless waves, the sounds in the phone agree with those from the transmitting station.

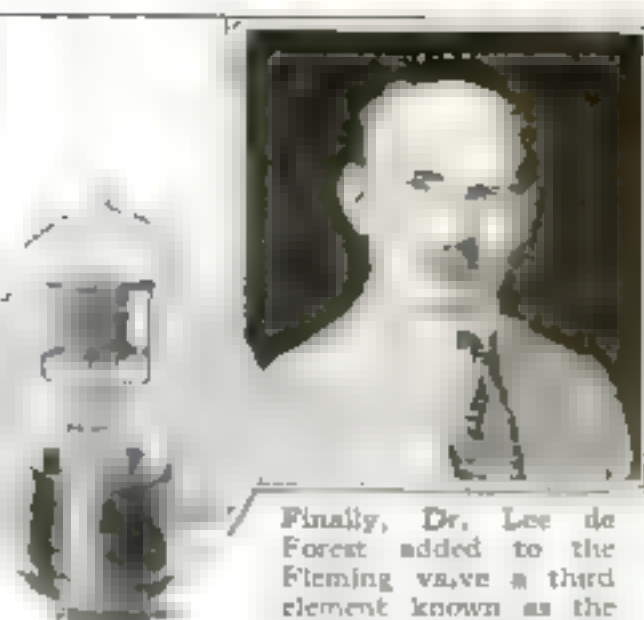
Three Makers of Vacuum Tube History



First, Thomas A. Edison, while experimenting with an incandescent electric light bulb, placed a metal plate inside the bulb near the filament and discovered the so-called "Edison effect," later applied by others to radio.



Next, Prof. J. A. Fleming, seeking to improve the wireless detector, produced the first vacuum tube, known as the "Fleming valve," using the "Edison effect."



Finally, Dr. Lee de Forest added to the Fleming valve a third element known as the "grid," producing the vacuum tube as it is in use today.

with the others. Nor is this all. In addition, several ordinary two-way telephone conversations can also be carried on at the same time on the same wire without interference, while those 40 telegraph messages are being sent! Think of its commercial possibilities!

Vacuum Tubes Act as Filters

For an explanation, we must turn again to the remarkable vacuum tube so familiar to all radio fans. As is well known now, the vacuum tube can be turned into an electrical oscillator, if it is connected with a circuit composed of an inductance and capacity. Such a circuit will generate electric waves of tremendously high frequency.

Now, all that will be necessary is to have a sufficient number of vacuum tubes, all generating waves of different frequencies, and then to superimpose these frequencies upon the single wire running between the two cities that we wish to put into multiplex communication. The high

frequency currents are guided along the surface of this wire without interfering with each other, in just the same manner as waves of different sizes on the ocean will travel over each other and yet maintain their individuality.

At the receiving end there are other vacuum tubes, connected with circuits of different values in such manner that each will respond to certain frequencies and no others. In other words, each tube acts as a filter, straining out the different frequencies, and permitting only the one fitting itself to pass through to the recording device. An elaborately complex wave, guided along the wire, is thus resolved into its component waves by vacuum tubes at the receiving end, each message, when separated from the combined jumble, being separately recorded.

In this connection, a very interesting possibility cropped up the other day. I was at a dinner with Philip Berolzheimer, City Chamberlain of New York. During the evening, he asked me if it would be possible to broadcast orchestral or band

music, and reproduce it in all of the city's 40 parks, so that in each park, in the open air, 10,000 people could hear it clearly and distinctly.

I promptly discussed the project with E. B. Craft, Chief Engineer of the Western Electric Company. Without any hesitation, he declared the scheme would be possible, but suggested that the broadcasting be done over a telephone wire instead of by radio.

One Orchestra for Many Audiences

If the system proves practicable, it means that a city might support one really high class orchestra, and simultaneously deliver its music to any number of audiences in the open air. As a result of these discussions, it is probable that in the very near future New York City will put such a system through a series of tests. Wired municipal broadcasting of this kind, aided by voice amplifiers in the parks and public halls, would furnish music, entertainment, political debates, election returns, and in-

The Armstrong Regenerative Circuit and How It Works



The most advanced stage in the development of the vacuum tube came when Maj. Edward H. Armstrong discovered a means of increasing the strength of incoming signals without the addition of extra energy. By a special hook-up, known as the Armstrong regenerative circuit, he has made possible long

Maj. E. H. Armstrong

distance receiving of radio broadcasts. This hook-up is widely known, yet it is so intricate that few really understand how it works. The purpose of the diagram above is merely to give a simple, understandable picture of the Armstrong circuit, without attempting to explain the more complicated details.

teresting civic information to the entire population of the city

Light Wires as Aerial

THIS talk of wired wireless brings to mind the fact that recently a number of fans have been experimenting with electric light wires for another purpose—that is, in place of the usual antenna.

Although I advise strongly against such experiments, except by qualified electrical experts, I must admit that some of the results obtained by using the electric light wire as an aerial have really been astounding. It has now come to the point, indeed, where an electric light company on Staten Island, N. Y., is actually urging its customers to use the wires for this purpose, and, moreover, the company maintains a service department for the purpose of advising radio fans just how to do so.

In the first place, it is absolutely necessary to have a condenser in this circuit, preferably a variable condenser, with a dielectric composed either of air or of oil. A half-ampere fuse is also necessary.

The manner in which the system is used is as follows: An ordinary two-bladed push-in plug, such as is usually connected with a lamp stand, has a wire attached to one of the blades only. The other end of this wire is connected with the fuse, and the fuse is connected with the condenser. Finally, the condenser is hooked up to the aerial terminal of the receiving set. Thus the condenser and fuse are in series. Of course, the usual ground connection is attached to the ground terminal of the receiving apparatus. The plug is then pushed into one of the electric light sockets. If no results are obtained, the plug is removed and turned around, so that the blade with the wire attached is in a different hole from that which it first entered.

Only a reliable electrician should make this attachment and supervise its installation. If inexperienced amateurs begin to experiment with it, we are going to have accidents and serious fires. Touching the wires may result in a nasty shock.

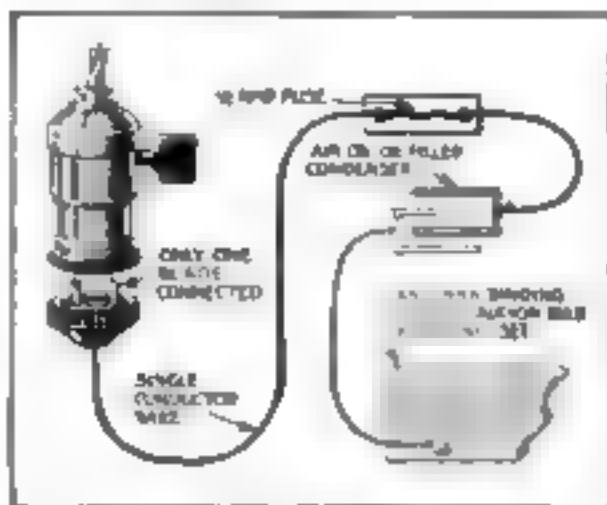
Two Sets at Once

SPEAKING of aeriels brings to mind the fact that practically every one (myself included) has persistently declared it impossible to successfully operate two or more receiving sets on a single aerial. In a general way this is absolutely true, but now comes Dr. Stephen Carleton, of Flushing, L. I., who reports to POPULAR SCIENCE MONTHLY that he is doing just that very thing.

The doctor has two regenerative receivers, one a honeycomb set; the other a variocoupler, variometer set. His aerial consists of a single wire 135 feet long, strung between two supports, and it passes through a veritable maze of trees, not more than 28 feet above the ground. In fact, it defies all rules governing aeriels.

Doctor Carleton used his two sets alternately, with the same aerial and ground. He was in the habit of disconnecting one set when he used the other. Both sets were operating from the same storage battery. One night, by the merest chance, he forgot to remove the aerial from one set, and connected the wire with the other. He had a pair of telephones joined up to the one he intended using, and the loudspeaker was attached to the other. To his amazement, he heard music in the phones, while the same music issued at the same time from the loudspeaker!

The astonishing event set him to experimenting. Subsequently, he tuned up to WYP at 1450 meters on one set, and WJZ at 360 meters on the other, and received simultaneously from both. This was fol-



How electric light wires can be used as an aerial by connecting the receiving set through a condenser and suitable fuse to one terminal of the ordinary light socket

lowed by receiving simultaneously Arlington time signals direct on the honeycomb set and the re-transmission of the signals from WJZ on the other set.

There is nothing very mysterious about the success of Doctor Carleton in having received stations of different wave lengths simultaneously on his two sets of apparatus. In fact, it is the ability of a receiving circuit to select a certain wave length and respond only to it that is the very basis of the "wired wireless" system, and it is this ability that has been responsible for the development of multiplex telegraphy and telephony by wired wireless.

Watch Armstrong!

EVERYBODY is wondering, these days, what is coming next in radio. "Wired wireless" is only one of many marvels that are turning up every month.

With the known facts at the present time, we can predict certain developments sure of realization in the near future. Among them is regular transatlantic radio-telephony, and transatlantic wireless telegraphy, at a speed of 600 words a minute. Moreover, there isn't the slightest doubt that the disastrous effects of static will be completely eliminated at receiving stations. This, of course, is going to be a tremendous boon to the owner of a home radio set.

But to my mind the greatest possibility of the future lies in the development of receiving equipment that will throw the outdoor aerial into the discard. Radio frequency amplification will accomplish this, but radio frequency amplification on short wave lengths seems to be a long way off. Besides, it is too costly at the present price of vacuum tubes. The ideal set must be one that does not employ more than three tubes. I am able to announce, however, that such a set is already here. How soon it will be ready for the market, I do not know.

It is the invention of E. H. Armstrong—who, as creator of the regenerative circuit, made possible broadcasting as we know it. The latest Armstrong achievement, I believe, consists of a super-regenerative circuit employing three tubes. This circuit is so good that with a three-foot indoor loop aerial in New York City, the set will reproduce concerts from Pittsburgh on a loudspeaker!

It is a strange coincidence that radio is

entirely a development of youth. Marconi was under 20 when he produced wireless telegraphy. Many leaders in its development have been young men. E. H. Armstrong, the latest in the series of young radio wizards, is still in his early thirties.

It might not be a bad idea, at this stage, to point out just which niche Armstrong fills in the radio Hall of Fame. To do so means detailing the story of the vacuum tube.

The vacuum tube was born in the laboratory of Thomas A. Edison, in the eighties. Edison was at the time experimenting with the incandescent electric light bulb. In one of the experiments he placed a metal plate inside the bulb near the filament. He then put a battery between this plate and one of the filament terminals, and noticed a very peculiar result. When the filament was burning brightly, a current from the extra battery passed around the circuit and registered on a voltmeter, despite the fact that there was no complete connection between the filament and the plate. Edison observed that when the filament was not burning, there was no current flowing in the plate circuit. This became known as the "Edison effect," but it lay dormant for three decades because Edison was too busy with other things.

Thirty years later Professor J. A. Fleming, in England, searching for a more efficient wireless detector, produced the first vacuum tube—the "Fleming valve," based on the "Edison effect." Shortly afterward Dr. Lee de Forest (Armstrong's late legal antagonist) added a third element known as the "grid," and made the vacuum tube a real device.

It was at this point that Armstrong entered the field, and devised the circuit that at one stroke turned the vacuum tube into an electric oscillator.

Inventions Needed

NOBODY can read about the success of such men as Armstrong without wondering whether fame and fortune can still be won in the radio field. Are there other big problems that we can specifically enumerate today, but must wait for the future inventor to solve?

Yes, there are. There is increasing opportunity, right now, for the young inventor to achieve fame.

As I said before, radio frequency amplification would eliminate the need of outdoor aeriels. It will be successful only if we have a perfect high frequency transformer. There's one opportunity.

Another opportunity is bound up in the development of a filter system that will successfully retard all extraneous currents, and permit only the signals from the station we desire to hear to pass through the receivers.

Still another is a successful choke that will hold back oscillations from the receiving set, and prevent them from being radiated from the receiving aerial, thus interrupting other near-by receiving sets.

We can do with electromagnetic waves just what we can do with light waves—reflect them and refract them. Now, one of the most urgent needs in these days of congested ether is a perfect system of reflection, that will send out a train of waves straight to the receiving station. Just think what such a system would mean in the way of secret communication! Moreover, it would reduce the amount of power needed in transmission. This will be the prize invention of all. Who is going to be the genius to produce it?



The Home Workshop

New and Useful Things for the Practical Man to Make

Barrels Support Simple Boat Landing and Float

By Stillman Taylor

OF SIMPLE construction, this float combines durability, buoyancy, freedom from leakage, and strength. It is also the cheapest form of float to make.

As lightness is desirable when the float is hauled from the water in the fall, the entire framework for the deck is best made from sound spruce. Spikes may be used to fasten the frame together, but it is better to dovetail the corners and mortise the ends of the cross timbers into the sides.

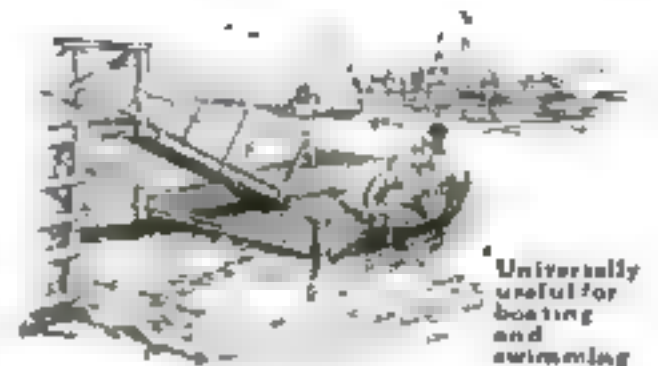
Common oil barrels attached with strap iron saddles may be used to float the deck. The barrel bungs should be plugged tightly. It is well to locate them so that the barrels may be pumped out from the deck in case of leakage. Ten ordinary barrels are sufficient, even when the platform is used by a large number of persons at one time.

The float is moored as shown by means of an iron ring or hoop at each corner facing the shore. This allows the

float to rise and fall with tide movements.

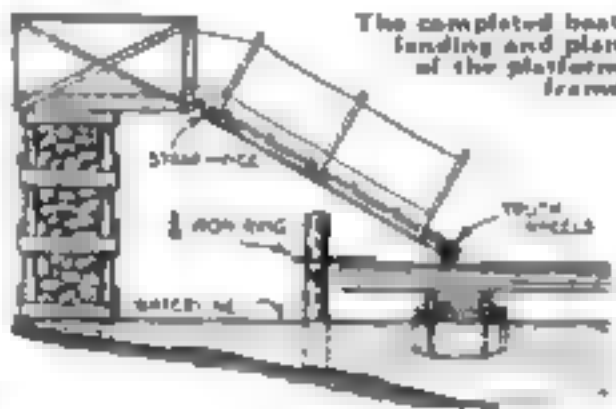
The dock from the shore is a simple runway, supported on stone-filled cribs. These are made of four piles driven down and boxed to form a square foundation, when it is filled with rough stone. The gang-plank has stanchions for the rope hand lines securely bolted through the frame. Cleats 1 in. square are nailed at 1-ft. intervals to prevent slipping.

The gang-plank is fastened to the runway with heavy strap hinges and the opposite end is provided with two iron truck wheels,

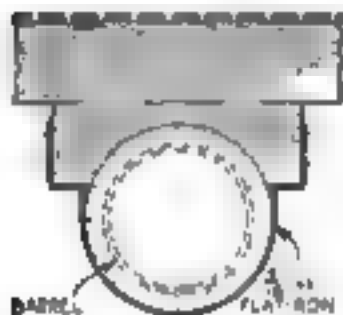


Universally useful for boating and swimming

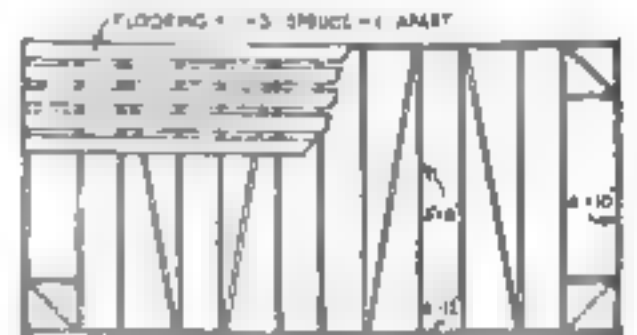
which roll on steel plates screwed to the platform. To protect the boats from chafing, the edges of the float should be provided with a bumper strip. This may be made of old fire hose or even a piece of heavy, discarded rope.



The completed boat landing and plan of the platform frame

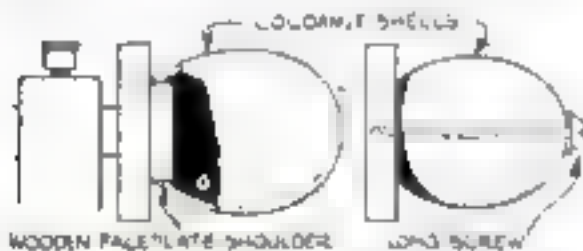


Fastening the barrels



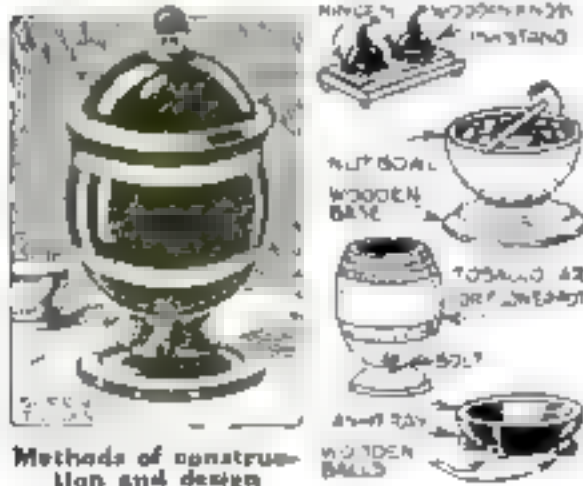
Cocoanut Shells for Ornamental Turning

IT IS surprising that so little use is made of cocoanut shells for turning useful and ornamental objects. They are strong, not difficult to work and take a fine polish.



WOODEN FACEPLATE SHOULDER

LONG SCREW



Methods of construction and design

a turned shoulder or using a long screw. Turn off the outer surface, which is rough and hairy, until the hard black part is reached. Use tools suitable for brass.

Finish with fine sandpaper and apply a little linseed oil on a rag, pressed hard on the shell while it is revolving in the lathe.

An attractive effect is obtained by leaving a band of the rough outer surface around the top of the cup, or whatever the object is to be. The final step is to turn the shell around and face off the sawed edge, and, if you like, clean up the inside. The piece sawed off the top may be fitted to the bottom of the main shell as a stand or base, or a separate wooden base may be made and the left-over piece used as a cover.

Shallow sections of the shell make fine trays for cards, pins, or ashes. Whole shells make good tobacco jars, flower vases, flower-pots, sugar-bowls, nut-bowls and button boxes.

A shell that is particularly symmetrical may be turned in the lathe before cutting it open and the entire surface cleaned up and polished. Then saw it in half lengthwise and you will have two unique receptacles that require only the trimming of the edges and the addition of little legs or bases to make them complete.

It is possible to cut designs with a sharp graving tool and fill them with white lead or powdered white sealing-wax dissolved in alcohol to make a thin paste.—HOWARD GREENE.

Making a Rustic Table from a Forked Tree Trunk

MANY trees marked for firewood can serve the double purpose of furnishing the woodshed with fuel and the garden with an easily made rustic table.

At the point where the trunk divides into branches one can sometimes find a formation of three or four boughs spreading out in such a way that by cutting off level on

Furniture for the garden



top and bottom, the stand or base for a table may be made. A suitable board top is nailed to the support and, if desired, small branches split in two lengthwise can be nailed around the edges of the top.

The maple-tree is one of the best for furnishing these table legs.—A. E. ZIPPRICH.

For any one who has access to a lathe, they hold out many possibilities.

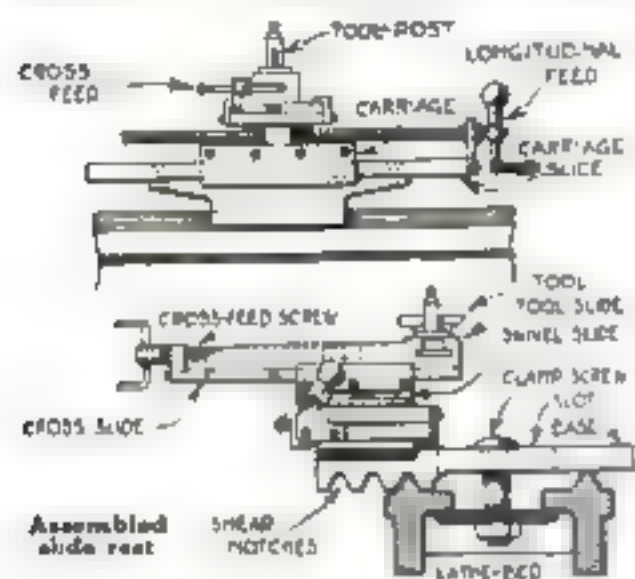
Select a shell of good shape, as nearly circular in section as possible, and saw off the top, leaving the body of the shell as deep as may be desired. Mount this on a wooden faceplate, either by forcing it over

Universal Slide Rest for Small Speed Lathe

THIS universal slide rest was designed by the writer for small lathes not equipped with the regulation engine lathe carriages. The construction is simplified for the amateur

By Joe V. Romig

and fastened to the slide bottoms with ordinary small buttonhead screws.



machinist, and the work, while it has to be accurate, is not difficult. The rest will transform a common speed lathe into a handy machine tool.

Both cross and longitudinal feeds are made possible by the use of slides, built with flat cold-rolled steel and angle members. The latter are made of $\frac{1}{2}$ -in. angle-iron, machined smooth on their inner faces

The base of the rest is a simple casting, machined as shown. It carries a slot in the web for the clamping screw or bolt. The heavy foot portion is machined top and bottom. The top carries a flat piece of cold-rolled steel fastened with flathead screws, which forms the slide for the carriage.

On the carriage is pivoted the swivel head and upper slide rest, turned up and shaped out of steel. The circular base is graduated in degrees for angle work. A $\frac{1}{4}$ -in. pin centers it to the carriage plate and the clamping is accomplished by two small clamps and hexagon-head screws.

The upper slide is built up of pieces of flat and square steel. A tool-post groove is milled as indicated at one end of the upper piece, which is tapered at the other. Flathead screws couple the two pieces together.

The cross-feed screw runs in a bronze nut fastened to the upper left angle member. The longitudinal feed screw has just room enough to pass beneath the swivel rest and runs in a small bronze nut fastened to the main carriage plate. The tool-post is of regulation design.

The construction of this rest from flat cold rolled steel saves much tedious machine work.

Making a Homemade Flashlight Bag

DISADVANTAGES of flashlight powder may

be avoided by the use of a flashlight bag, which retains the smoke largely in a cloth enclosure. Flashlight bags, even the cheapest, are too expensive for many photographers, but a serviceable and dependable bag may be made at home for less than \$3.

I made my flashlight bag to fit inside a suitcase, about 12 by 22 in. Buy a piece of composition board this size or to fit your own grip and make a baseboard 3 by 12 in.



Ready for a flash

from ordinary lumber. In the exact center of the latter a tripod socket is fastened and the baseboard and the bag are then fastened together with two brackets. A small door is cut in the composition board and fastened with two hinges at the bottom. To it is attached a powder-pan and, about 1 in. above the pan and 1 in. apart, two binding-posts. Two $\frac{3}{4}$ -in. boards 8 by 22 in. are hinged to the edges of the composition bag; these fold inward.

The bag is then wired as shown. The flash powder is ignited by the burning out of a fuse, which is nothing more than thin wire fastened to the binding-posts and dipping into the powder in the powder-pan.

An ordinary socket and lamp are placed above the flashpan, forming a guide-light

By Frederick C. Davis

by which can be estimated the exact shade-

ing the flash will make when it is ignited. A pushbutton is inserted in the circuit for setting off the powder with about 10 ft. of cord, so that the photographer may manipulate the flash-bag some distance from the flash.

Finally a piece of closely woven cloth is tacked all around the edge of the composition board and also to the wings. If desired, this cloth may first be fireproofed by dipping it in a solution of sodium tungstate.

When in use, the door in the back of the cabinet is opened and a piece of fine wire, such as is used in flexible cords, is fastened by its ends to the two binding-posts, letting the middle of it dip against the bottom of the powder pan. Then put the proper quantity of powder in the pan, close the door, and, when ready, press the pushbutton, which will ignite the flash certainly and instantly. The smoke will remain in the bag.

It is best to place a safety contact in the circuit. Such a switch can be made from a piece of spring arranged so that when the door is open it does not make a contact. In this way no accidents are possible.

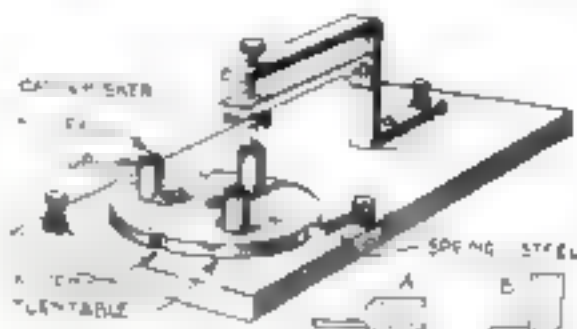
HEAVY sheet brass may quickly be reduced to paper thickness for thin gaskets, shims, and the like by dipping it repeatedly for a few seconds at a time alternately into nitric acid and water.



Guide-light wiring, and powder-pan

Wire Terminals Used as Mineral Cups in Unique Detector

BUILDING a mineral wireless detector recently, I was at a loss as to what to use for mineral cups. Eventually I hit upon the idea of using ordinary copper wire terminals. These were mounted as shown upon a brass turntable that revolved on a



The cups are mounted on a turntable

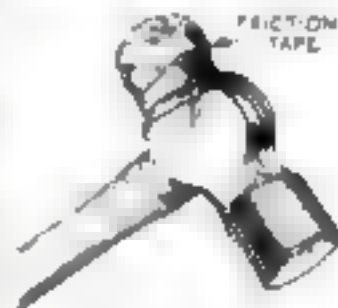
pivot and was held in position by a spring engaging notches on the periphery.

The support for the catwhisker is of brass, arranged as shown. The case with which a fresh mineral may be swung into place makes this detector a useful one of its type.—LEK GOLDSTEIN

Improvising a Soft Mallet

WHILE working recently on a large armature and replacing coils in a stator far from shop facilities, I discovered that I had failed to include a rawhide mallet in my tool-kit.

I took a ball-peen hammer of the right weight and securely wrapped the ball with friction tape, thus making a soft mallet, as shown. It proved most effective, more weight could be obtained with it than with the ordinary rawhide mallet.—B. SIMS.



Padded with tape

A Cart with Shock Absorbers

THE illustration shows the springs that I have provided for a child's cart. Procure four ordinary bed-springs, preferably 4 in. long—two for each side of the



Springs make it ride like a Hummer

cart. They are put together and securely stapled to the top and bottom cross pieces. One bed-spring on each side would be too weak. The bottom cross pieces are provided at one end with T hinges, that are screwed or bolted to another cross piece. The axle is attached to blocks that are screwed to the cross pieces.

The box can be made suitable to the needs of the builder. The wheels should be 12 in. in diameter.—H. A. GLASTON

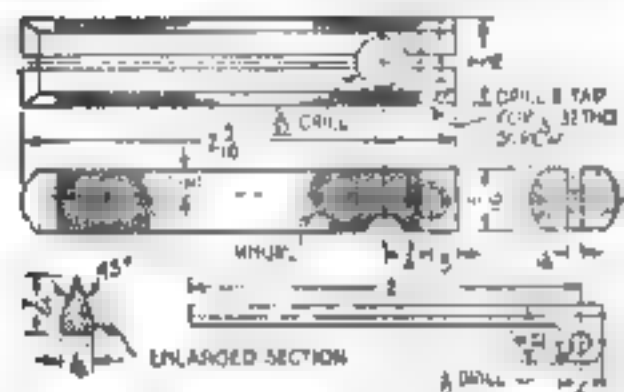
How a Toolmaker Simplifies Tool Construction

By S. L. Roberts

IN MAKING tools for my own use, I have worked out several ideas that may be of service to toolmakers and machinists.

My planer gage is made without the usual T slot and is therefore of simpler construction than the gage as ordinarily designed. A $\frac{1}{4}$ -in. drilled hole takes the place of the slot, which does away with the necessity of using a small Woodruff key-way cutter in machining the gage.

My diameter's square is only a piece of drill rod, knurled. The blade is an old file, drilled at the one place where a file is not hard—the tang. By taking advantage of this fact, I avoided the necessity of having to



Making the Most of Your Summer Outings

Seasoned Sportsmen Offer Valuable Hints for Camper and Fisherman

This Tent Cellar Will Be Found Invaluable

BY DIGGING a hole in the ground underneath your tent and constructing a trapdoor over the opening, a miniature cellar is easily made. A rack of shelves can be built of some wooden boxes and placed in the opening, and upon these shelves, food, dishes, and utensils can be stored. From small hooks or nails along the sides of the floor opening, cups, frying-pans, tools, and other articles can be hung. Used to store supplies, it serves as a refrigerator and at the same time saves valuable tent space. When the campers find it necessary to leave their tent for any considerable length of time, the opening in the ground can be used as a hiding-place for articles of value.

With a little care the floor can be constructed so that the opening will be unnoticeable, unless its existence is known. The instructions given below also apply to building a plain floor of a tent. The camper should bear in mind that a good tent floor adds much to the comforts of camping.

For a 8 by 12 ft. tent the trapdoor should be 3 ft. by 3 ft., situated to one side. Joists are 2 in. by 4 in., spaced as shown. The two small-length joists that act as supports for the trapdoor are put in place and nailed to the other joists after the door has been sawed out. For flooring use $\frac{3}{4}$ by 4 in. planks dressed and tongued and grooved if possible. Order an extra amount to allow for waste. Reserve the best boards for the center of the tent. Starting

at one side, place the grooved side of a board flush with the edge of the joist.

The boards should be nailed blind. That is, the nails should be driven into the edge and countersunk with a small punch. A nail with the point filed off can be used for a punch. Blind nailing prevents any nail-heads from showing in the finished floor.

In driving the boards together, to secure a good fit, the hammer should not be used directly on the tongue of the board, as it

will splinter. A piece of board 18 in. long, fitted with its grooved side to the projecting tongue of the board being laid, is used to drive the board into place. The door is sawed out as shown in the illustration as soon as a sufficient number of boards has been laid.

Before sawing, two strips of wood are nailed over the boards that are to form the door, to act as temporary cleats. The

joists will act as a guide to the saw. The tongue of the outside board forming the door is cut flush with the edge. The two small joists, each about 6 $\frac{1}{4}$ ft. long, are set in place to act as supports for the door. The rest of the floor is then nailed down in a similar manner.

To finish the trapdoor two strips of wood are screwed on the under side, using enough screws to hold the boards of the door firmly together. The temporary cleats on the upper side are removed and two small holes drilled in the door so that it can be lifted with the fingers.—BENJAMIN FOX.



Camper who remains in the same place for a considerable time should build a cache under the tent floor.

Tin Cans May Be Used as Camp-Stoves

IN AN empty gallon can that has been opened at one end only, cut two holes corresponding to the feed door and the pipe hole of a drum stove, the feed door being at the end that has been opened and four times the size of the pipe holes.

After thoroughly cleansing the can put it on the ground with the hole end up. Build a fire inside and the top will soon become hot enough to fry eggs and bacon or cook anything that can be cooked on top of a stove. When a bed of coals has accumulated, a steady heat can be relied upon.

With a battery of four or more of these stoves, cooking can be done for a dozen or more campers far more easily than over open fires, on account of the flat surfaces provided, the better control of the smoke, and the more uniform heat. In moving camp the cans become convenient recep-



Time for stew.

tacles in which to pack provisions and other articles, and at the end of the season, having served their purpose, they can be thrown away.—ARMSTRONG PERRY.

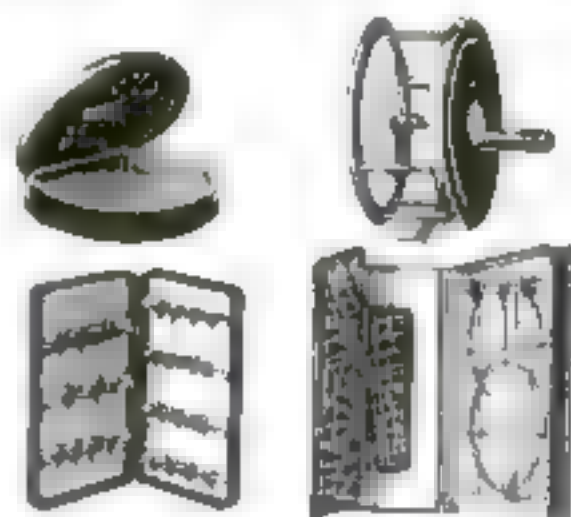
Fly Casting Equipment for the Trout Fisherman

SOME anglers will tell you that fly casting is a fad, but the experienced fisherman well knows that is a mistake. Everything considered, as many if not more trout are caught on the fly as with bait, and there is a great deal more pleasure in handling the lighter tackle.

Good tackle—and by good tackle is meant a fishing outfit well suited to the sport, rather than tackle that is merely expensive—makes for good sport, while shoddy, unsuitable tackle is never to be tolerated.

A light rod is the choice of the expert. For average fishing, the 9 $\frac{1}{2}$ -ft. fly rod is a good choice. The handmade split bamboo rod is the best, but for the beginner a cheaper rod will answer. A machine-made bamboo fly rod will be found more serviceable and of better action than an all-wood rod selling for the same price.

Here is a little hint about picking out a bamboo rod. Joint the rod in the store,



A good style of trout reel and cases for flies and leaders.

and put on a reel of the same weight you intend to use. Make a few imaginary casts with it to find out its balance and action. The dealer will be glad to assist you, so wind a few yards of line on the reel, run it through the guides, and on the end of the line tie a small weight, which should be placed on the floor. Back off 10 or 15 ft., and bring tension on the rod; then you will gain a good idea of its strength and flexibility, as you reel in the line. Next, hold out the rod at arm's length and sight along it. Should it bend considerably, discard it for a stiffer rod. Every light rod will bend somewhat, but a pronounced curve indicates a "whippy" rod, not stiff enough for your purpose.

The reel plays a minor part in fly fishing, provided it is of a correct size to hold the line and of a weight to balance the rod. The most suitable reel for fly fishing is a single-action click reel with a handle fastened directly to the revolving side plate. This reel is known as the "British style," and its superiority lies in the fact that there

(Continued on page 97)

August, 1932

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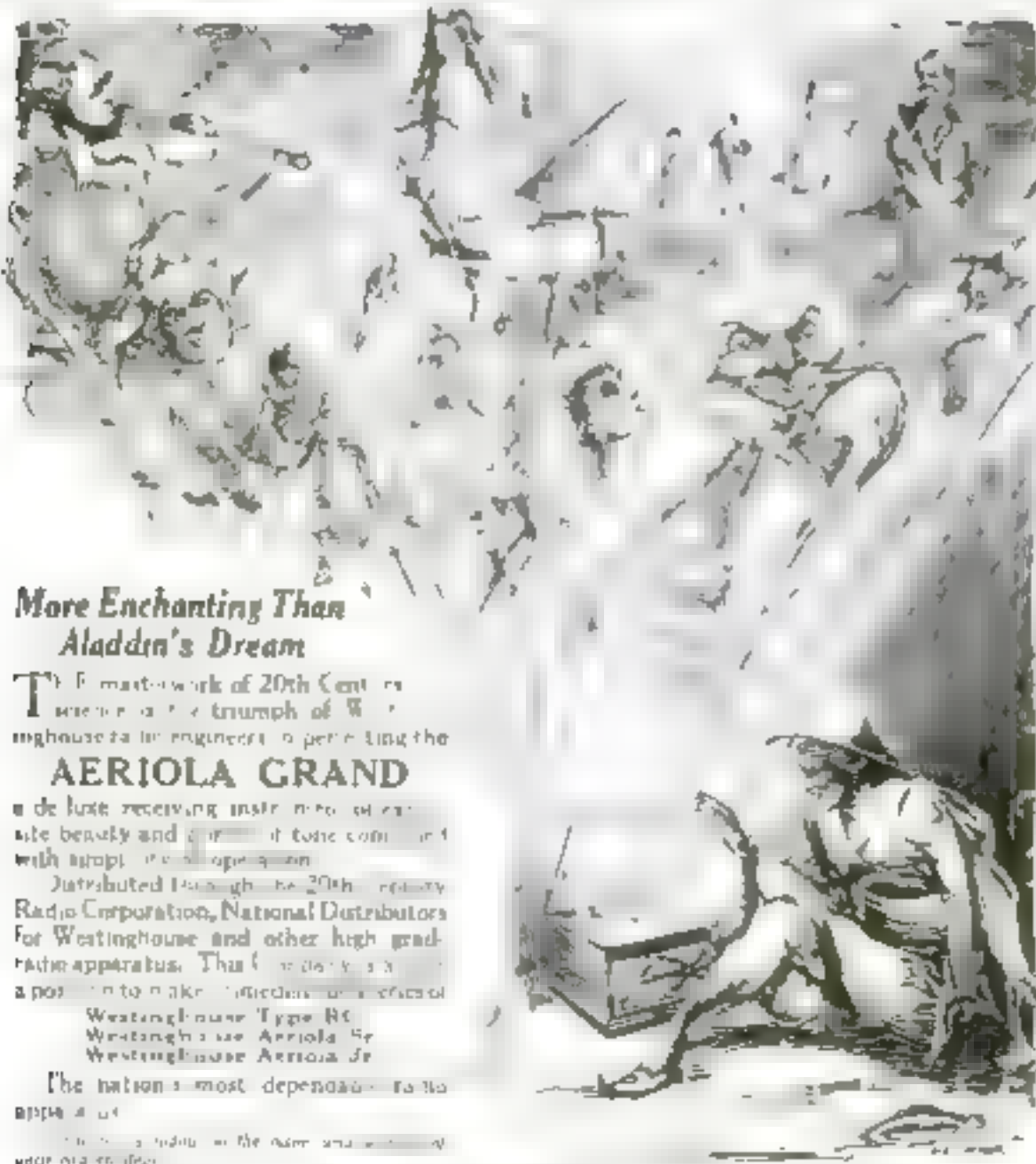


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THE HOME WORKSHOP

IT WILL PAY YOU TO PASS ALONG YOUR "BEST IDEAS"

THOSE good ideas and useful "kinks" you work out from time to time in your home workshop would be pretty sure to help the other fellow when he is confronted with similar problems. So send them in to the Home Workshop Editor, POPULAR SCIENCE MONTHLY, and compete for the bonuses awarded for the "Best Ideas" published in this department every month.

Your article or letter may treat of any subject of interest to Home Workshop readers. It should be kept as short as consistent with all possible clearness and accuracy, and illustrated with diagrams, sketches, or photographs. The drawings need not be "pretty" provided they are understandable. It's the idea that counts.

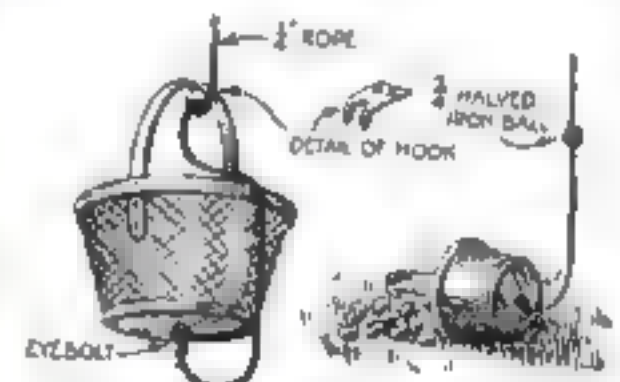
For the items selected for publication, POPULAR SCIENCE MONTHLY pays well and in addition gives monthly prizes. The awards for September will be a \$15 bonus for the best idea published and \$10 for the second best.

The prize-winners for August are
FIRST PRIZE, \$15: S. L. Roberts,
Hoboken, N. J. "How a Toolmaker
Simplifies Tool Construction" (see page
79)

SECOND PRIZE, \$10: F. W.
Wilder, Watertown, Conn. "Fruit
Picking Made Easy by Self-Emptying
Basket" (see below)

Fruit Picking Made Easy by Self-Emptying Basket

MANY apple pickers carry a bag tied at diagonal corners and slung across the body, but this bruises the fruit and necessitates climbing up and down the ladder frequently. In its place I have used a half-bushel basket, to the bottom of which a 1/4-in. rope about 25 or 30 ft. long is fastened by means of a rivet or eye-bolt. To the center of the handle a slotted hook



This basket saves climbing constantly up and down the ladder

is riveted. This engages a knot or a 3/4-in. halved iron ball on the rope, as illustrated. The basket is suspended from a tree limb by means of the hook while the fruit is being picked. When it is nearly full, the knot or ball is caught in the slot in the hook and the basket is lowered to the ground. As soon as it touches the ground, the knot or ball drops from the hook. A pull on the rope inverts the basket and turns out the fruit and the basket can then be drawn up for refilling.—F. W. WILDER.

THE HOME WORKSHOP

Protecting Spring of Porch Swing
from Breaking or Slipping

Guard chain prevents spring's being strained to breaking point

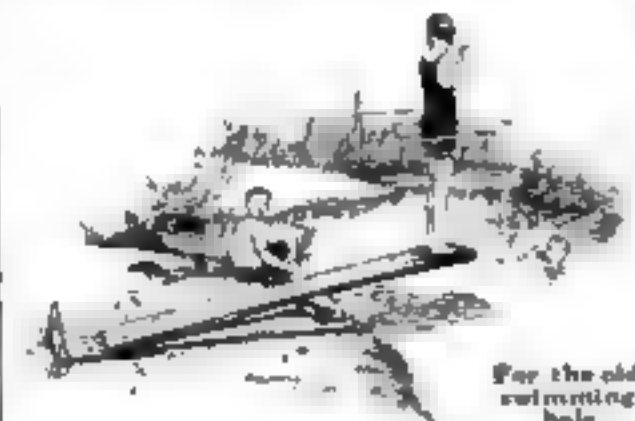
ACCIDENTS are sometimes caused by the failure of supporting springs used in connection with porch swings, either because the springs are not properly fastened or break.

By fastening a guard chain around the spring as shown above, all danger of the spring being overstrained or becoming unhooked is avoided. — M. J. CLERTIS

Fruit Picking without a Ladder

THE gardener who has only one or two fruit trees can often save himself considerable trouble in picking fruit by using a long bamboo pole, to the top of which is wired a tin can. The edges of the can should be filed or ground as sharp as possible.

To cut fruit off with this device, push one edge of the can between the limb and the fruit and make a quick upward motion. This will sever the stem and leave the fruit in the can. — C. W. STEPHENS

Old Wagon Spring Was Used in
Building Portable Diving Board

For the old swimming hole

A SIMPLE spring board for the old swimming hole can be constructed easily by hinging together two planks as shown, so that the top one extends a few feet beyond one end of the lower plank. The lower one is firmly staked down and a buggy or wagon spring is placed between the two planks. — CHARLES A. BLACK, JR.

A FLEXIBLE under coat for painting canvas tents can be made by putting 2 oz. of sulphate of zinc in 3 pt. of water, thickening the solution with whiting to a paintlike consistency, and applying to the canvas. After it is dry, paint the tent with two coats of white lead paint.

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This book tells how to finish wood in artistic stained and enameled effects. Gives practical suggestions on making your home artistic, cheery and inviting. Tells just what materials to use and how to apply them. Includes color card—gives covering capacities, etc. Use coupon below.



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CITY & STATE

THE HOME WORKSHOP

Blueprint Will Aid You in Making This Comfortable and Attractive Porch Swing

A PORCH swing that is as comfortable as it is ornamental forms the subject of this month's woodworking blueprint, prepared by the Home Workshop Department to aid tool users who like to make things for the home.

The graceful curve of the back of this swing and the decorative apron in front, below the seat, at once distinguish it from ordinary commercial porch furniture of similar construction and give it that attractive originality that the craftsman constantly is seeking.

Both the back and the seat curve in such a way as to provide for the maximum comfort even if cushions are not used, and the swing is intended for use either with or without cushions.

The seat is about 3 ft. wide and 20 in. deep; the back is 2 ft. 4 in. high; the over-all length is 4 ft., and the over-all depth 2 ft.

To insure durability, the swing should be made from a good serviceable hard wood, such as ash or oak. Two sleepers or stretchers, to the ends of which are attached the chains, support the four seat rails and the two arm frames. The back is connected with the arm frames by means of carriage bolts, which serve as pivots, so that the seat can be adjusted to various angles and held in place by means of short tie chains that connect with the main supporting chains. The full details of construction, which have been simplified as far as con-

sistent with good workmanship, are contained in the blueprint, which has also a complete bill of materials or cutting list.

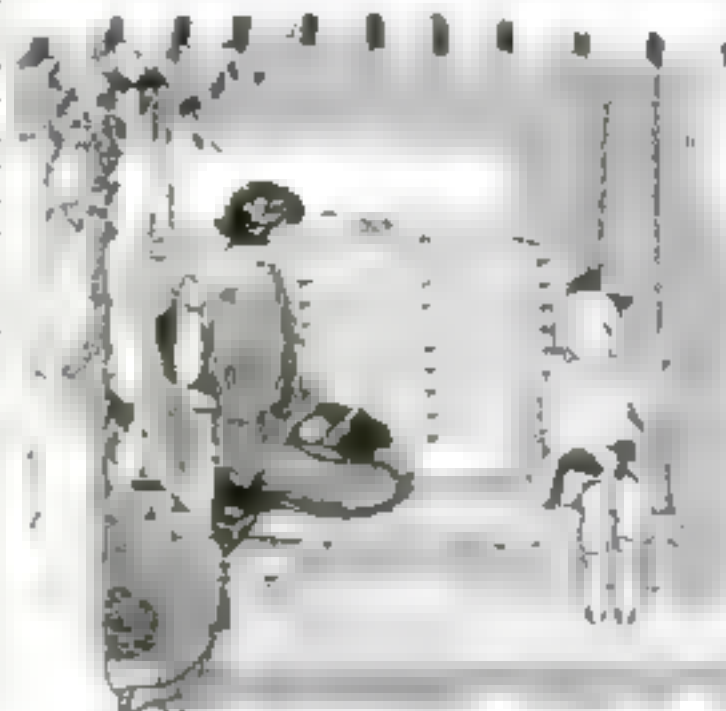
To add to the resiliency of the swing, spiral springs can be added to the chains, if desired.

Every care should be taken in finishing the swing. It may be stained dark oak or finished to match other porch furniture, or it may be painted to match the house body color or trimmings, or to contrast harmoniously with them. In any event, considerable thought should be given to selecting the most appropriate method of finishing for the particular location in which the swing is to be used. If it is painted and is not to be used with cushions, a few touches of stenciled ornament, properly placed,

will add considerably to its appearance. The chains, which are the least ornamental part of the swing, may be improved by casing them in brown or green burlap or, if cushions are to be used, in tubes sewn from strips of the same material.

To obtain the blueprint for this or any other project so far published in the Home Workshop series, check the coupon below and send it, together with the necessary remittance of 25 cents a sheet, to the Blueprint Service Department.

For a picture of the radio blueprint set, No. 6, and a few comments of readers who have used it, see page 87.



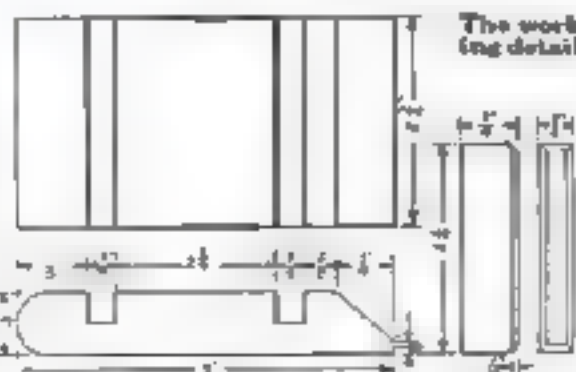
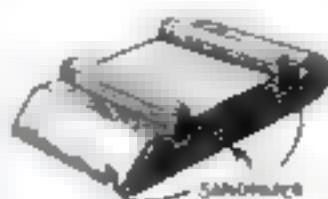
The back is adjustable and both it and the seat are shaped to provide the maximum comfort.

Sandpaper Block for Fine Work

WITH this block the sandpaper is always in place and yet can easily be changed. It is made of soft pine $\frac{1}{2}$ by $2\frac{1}{2}$ by 5 in., with two grooves cut across the back. Into these

fit the two small blocks that hold the sandpaper, which should be torn off the short way of the sheet.

—JAMES A. HOSKINS.



Coupon for Ordering Blueprints

Blueprint Service Dept.
Popular Science Monthly
225 West 39th St., New York

GENTLEMEN

Send me the blueprint, or blueprints, I have checked below, for which I inclose .. cents in stamps or coin

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3.	Book Trough End Table ..	25c	<input type="checkbox"/>
4.	30-ft. Monoplane Glider ..	50c	<input type="checkbox"/>
5.	Kitchen Cabinet	25c	<input type="checkbox"/>
6.	V T Radio Receiving Set ..	25c	<input type="checkbox"/>
7.	Shaving Cabinet	75c	<input type="checkbox"/>
8.	Arbor with Gate and Seats ..	25c	<input type="checkbox"/>
10.	Porch Swing	25c	<input type="checkbox"/>

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Street

City and State

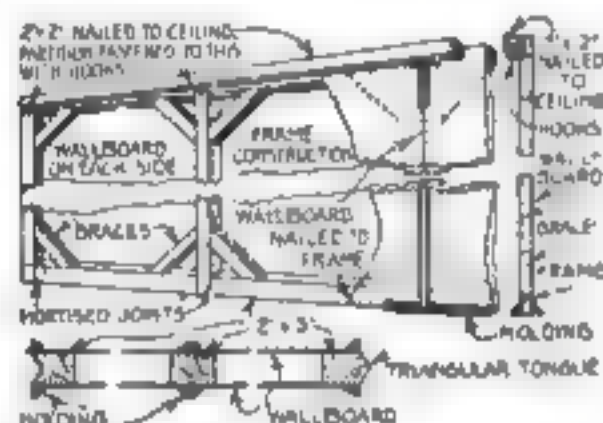
THE HOME WORKSHOP

Removable Wallboard Partitions
Are Cheap and Durable

FIBER wallboard is useful in the construction of removable partitions, provided some simple interlocking system is used for holding the sections together.

A few years ago a village church needed partitions in remodeling the basement. At times the whole room was used for social gatherings, so permanent partitions were out of the question. A low ceiling made rolling screens impractical and steam pipes made it impossible to use folding or sliding doors.

The following plan was finally evolved: Frames of 2 by 2 in. soft pine were constructed and well braced at the corners. They were 8 ft. 6 in. wide, and 9 ft. high, the height of the ceiling. One edge of each had a triangular groove, and the other a triangular tongue. On each side of the frame a sheet of fiber board was nailed.



How the individual sections are constructed

Light moldings along the edge and through the middle gave a paneled effect to the sections.

The doors for each room were constructed in a similar manner and were hung on double acting hinges attached to an ordinary section.

The steam pipes promised some difficulty at first, but this was overcome by building a small section around each intersection and fastening it permanently in place. The large sections were fitted up against these.

To secure the whole in place, 2 by 2 in. pieces were nailed to the ceiling, following the shape of each room. The sections were then fastened to them with common hooks and eyes.

This plan is entirely practical and cheap. The entire system, in this case about 150 linear feet, can be taken down or put up in twenty minutes by two men. By making the sections 42 in. wide, any length up to 10 ft. can be handled with ease. Wider wallboard can be used where the partitions are not removed very often.

This makes a more durable wall than would be imagined; some or all of the sections have been taken down nearly every week for six years.

The dead air space makes the rooms nearly as soundproof as an ordinary lath and plaster wall.—GEORGE W. WILSON

Not every radio vacuum tube requires a grid leak with the grid condenser, but if your tube acts peculiarly, with weird noises in the receivers, make an experimental leak by drawing a pencil mark between the binding-posts of the condenser. The resistance of this leak can be increased or decreased by erasing or adding to the width of the mark.—R. M.

"A MAN'S A MAN
—WITH A CYPRESS PLAN."



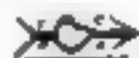
The Master
Cypress
"The Wood Eternal"

It's Fun to Make Furniture—

and also easy—if you simply provide yourselves with the necessary pieces of Cypress, "the Wood Eternal", and Volume 38 of the internationally famous Cypress Pocket Library. It deals truthfully and simply and graphically with "home-grown" furniture for amateur craftsmen. It contains fully detailed plans and specifications for 7 artistic pieces. Also how a buffet and piano stool may easily be made by slight adaptations of the plans for the library table and the tabourette (That really makes 9 altogether.) Also—as a side thought—why not cut down the dimensions and make two or three pieces of children's furniture? Good idea! It's a pleasure to do it, a pleasure to work in so "kindly" a wood as Cypress—and what a pleasant surprise for birthdays and Christmas! Father's own handiwork! Better send for Vol. 38. (Furthermore, your familiarity with "the Wood Eternal" will insure your use of it in many other ways—especially outdoors—to your great advantage.)

Vol. 38 is the "Home-Grown" Furniture Book 52 pages, 13 pictures, 7 working plans with full specifications. 1 special Art Supplement. FREE on request. Write. (Also ask for Vol. 43, a surprise book.)

SOUTHERN CYPRESS MFRS'. ASSN.



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Insist on **TRADE-MARKED CYPRESS** at your local lumber dealer's. If he hasn't it please advise us promptly and we will see that you are supplied.

HOW CAN I HOOK UP MY SET BETTER?

Is there some change I can make that will get me the distances others are getting? How can I get sharper tuning with my present outfit? Is there some source of information about the newest hookups, the latest developments, improved types of aerials that is really dependable and never grows old? Yes

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Just out in the first real authority on all radio questions. It is the one source of radio information that is not opinionated, not hearsay, but tells authentic facts.

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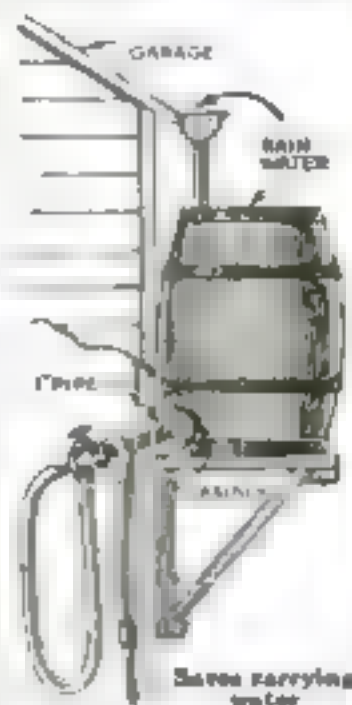
\$3.50

THE HOME WORKSHOP

Radiator Water Supply Obtained from Barrel of Rain Water

BY USING a barrel, some discarded lengths of tin gutter, a piece of iron pipe, and a short rubber hose, I was able to provide my garage with a source of water supply for the radiator of my automobile. This saved the necessity of carrying water from the house.

The barrel was placed on a bracket where the rain water from the roof would collect in it, and there was always a good supply available. The installation cost nothing but my own time and labor.



ROY H. POSTON.

Luggage Bags for Motorcycles

PACKAGES and other luggage are best carried on a motorcycle in bags hung from the sides of the regular carrier. This method is especially good when the carrier has to be used as a rear seat.

The bags of any convenient size, should be made of very strong canvas or leather.



The bags to use

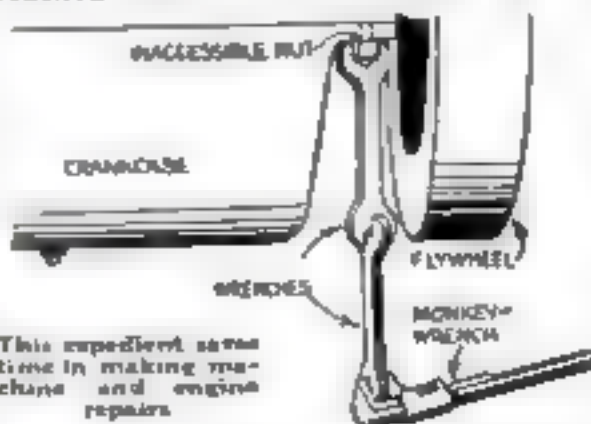
Two small harness snaps are attached to the upper corners and hook into small eyes riveted to the under side of the carrier. A short strap and button on the back of the bag fasten its lower end securely to one of the braces.

A thin hardwood strip should be inserted in the top and the bottom edge of the bag to hold each bag in shape and keep the corners from being blown into the chain and sprockets.

CHARLES ALBERT

Two End Wrenches Sometimes Will Reach Inaccessible Nuts

A NUT that is hard to get at with a single wrench sometimes can be reached with two end wrenches held to-



This expedient saves time in making machine and engine repairs.

gether. Hold one wrench on the nut, insert the other wrench in its end opening and apply a monkey-wrench, as shown in the illustration.

J. C. OTTOFF



Off to Vacation Land

FAR from the monotony of the crowded city—away from the automobile-infested dusty main-roads—out where the air is cleaner, the grass greener and the picnic places more inviting—why, man, there's a new world waiting to be explored by you, your pal and a Harley-Davidson!

Harley-Davidson "World's Champion Motorcycle"

And, to all the pleasures and thrills of the greatest sport in the world, the Harley-Davidson adds economy. Fifty miles for a dollar—gas, oil, tires and a lot that's all it costs. Think of the fun you can have with a Harley-Davidson at so small a cost this summer.

Your local dealer will give you a free demonstration of the Harley-Davidson. Also the reduced prices and an easy payment plan. Or write us for illustrated literature.

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Radio Department Detroit, Mich.

THE HOME WORKSHOP

Home Workshop Radio Blueprints
Praised by Readers

READERS of POPULAR SCIENCE MONTHLY have been genuinely appreciative of the radio blueprints included in the series of working drawings that the Home Workshop Department is issuing for the benefit of its tool-using friends.

These blueprints are a sort of extension of the Home Workshop. They are drawn to larger scale and are more fully detailed than the illustrations in the magazine, which are limited by the hard and fast boundaries of the printed page. Therefore they appeal to the mechanic and the craftsman who likes to spread a really good and workmanlike blueprint on his bench before he unlocks his toolchest and starts to get out his stuck.

Since the blueprint service was started last February, many letters of appreciation



Blueprint No. 6 gives details of this vacuum tube set, which can be made with or without two stages of amplification.

have been received. Extracts from a few of those referring to Blueprint No. 6, Radio Receiving Set with Two Stages of Amplification are as follows:

"I have constructed a radio receiving set with two stages of amplification in accordance with the blueprint published by the POPULAR SCIENCE MONTHLY Home Workshop Service Department. With ordinary attention given to details, I found the set simple to construct and wire. So far, I haven't seen a commercial set that compares with it in sensitiveness and selectivity. At present I am employing only my bed spring as an aerial, using but one stage of amplification. With that I am able to get the surrounding broadcasting stations very satisfactorily."—F. W. H.

"I must say that blueprint is one of the best of its kind that I have ever seen. I have read and studied many telephone blueprints in my time, covering all the systems manufactured, and I have met with none to equal the drafting and finish of yours."—R. R. B.

"Just received the blueprint of the radio receiving set as described in the May issue of POPULAR SCIENCE. It's a 'dasher.' It is just what I have been looking for the past two months."—J. F.

"I am interested in your radio sets, and have found your blueprint very easy to work from. I have made every bit of it so far that is on the print except a transformer, and I would like very much to try and make that. I can afford to buy one, but the fun is to try and make my own set complete."—W. E. McF.

"Though I am ignorant in regards matters radio, I have your complete set of drawings, and any man that can't follow their concise, understandable directions had better sell his tools."—A. F. B.

GOODELL-PRATT
1500 GOOD TOOLS

Micrometer
Caliper
with Ratchet Stop
No. 2 R
Price, \$13.50



The Ratchet, by always applying an equal amount of pressure, enables more uniform and accurate measurements to be taken.

"You can't fool a skilled machinist about tools," says Mr. Punch.

"He can tell when they're good with his eyes closed."

Yes—you can tell a good tool by its "feel." Take this Ratchet Micrometer, for instance. See how conveniently the ratchet is located. It can be operated with the same hand that holds the instrument, so your other hand is free to hold the work you're doing. The workmanship, accuracy, quality, of Goodell-Pratt Micrometers are known and appreciated by most users of high-grade tools.

You can tell they're good by their *feel* as well as by their looks.

They prove they are good by the way they perform

If you could see the infinite pains taken in making all Goodell-Pratt 1500 Good Tools, the laboratory tests of the raw materials used, the quiet efficiency in the making, the highly sensitive machines used in their construction, the skilled workmen hand-finishing them, the minute inspection before a tool is packed—

Why, men, if you could see with your own eyes the exacting precautions taken to insure all Goodell-Pratt Tools coming up to the 100% standard set for them, you would say the same as thousands and thousands of other good workmen say,

"Goodell-Pratt 1500 Good Tools are good enough for me!"

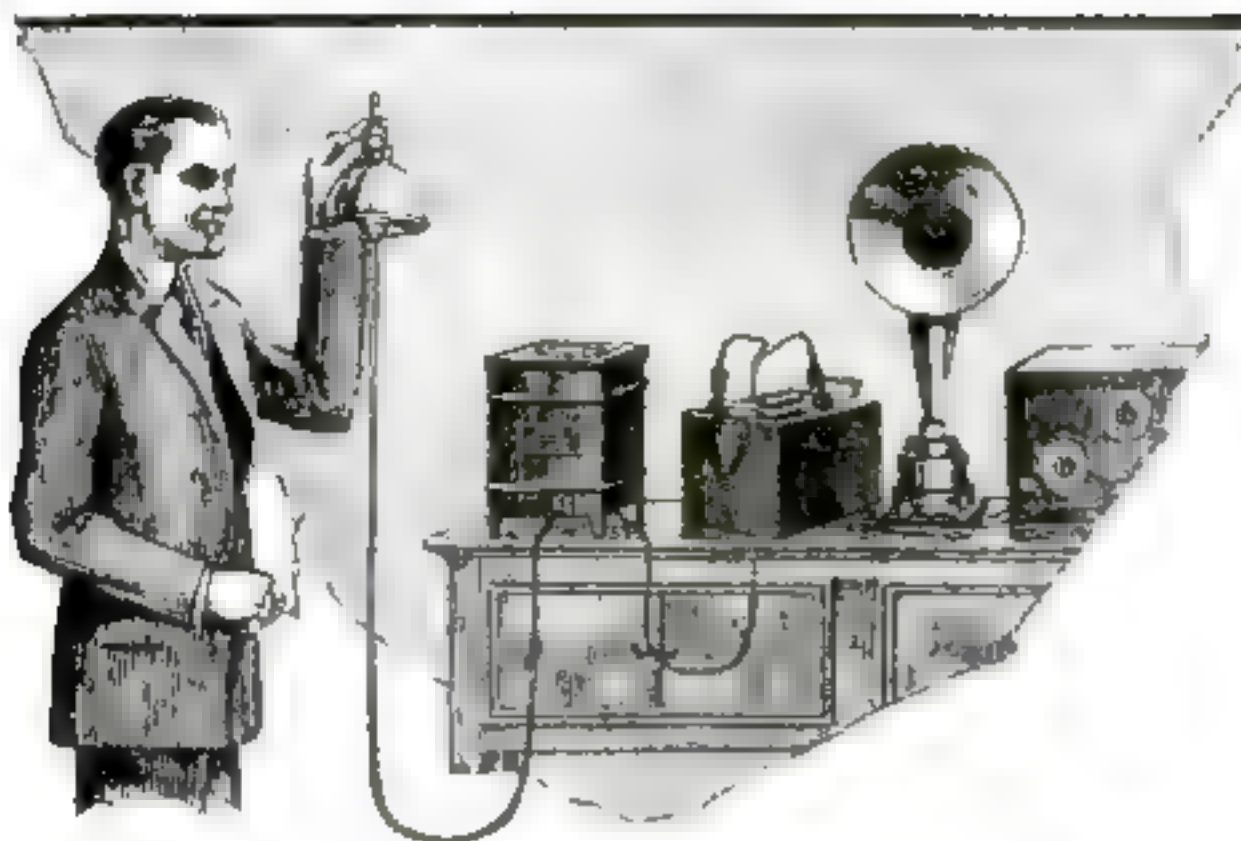
GOODELL-PRATT COMPANY

Toolsmiths

Greenfield, Mass., U. S. A.



Write for free illustrated pocket edition catalog describing the Goodell-Pratt 1500 Good Tools. You'll find much to interest you in it.



Charging Storage Batteries Easy as Turning on the Light

Tube sets require storage batteries, and they in turn require charging. You can do this at home merely by turning on the electricity, if you have a Tungar Battery Charger.

Tungar is a device for changing alternating to direct current. It allows the current to flow only in one direction. It requires no attention while operating. Its first cost is not high and its cost of operation is extremely low.

Tungar Battery Chargers were developed in the research laboratory of the General Electric Company over six years ago. Thousands have been in successful operation ever since.

Do you prefer to carry your battery to a charging station, wait a couple of days or more, and then pay three times what it would cost you to charge it at home? Our new booklet on the application of Tungars to radio batteries will give you the details. Ask us for Booklet B-3640, if your dealer cannot give you one.



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By Prof. T. O'Connor Shreve. The student to be followed, methods of work, field of operation and the requirements of the successful electrician are pointed out and fully explained. 202 pages. Illustrated. Price, \$1.50.

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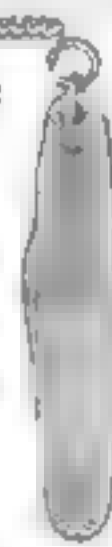
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THE HOME WORKSHOP

Modified Radio Regulations Aid Installation of Receiving Sets

BY TENTATIVELY revising its strict regulations in regard to radio receiving apparatus, the National Board of Fire Underwriters has made it a simple matter for every one to comply with the requirements.

The principal precaution is to use an approved "protective device" for the lead-in wire as near as practicable to the point where the wire enters the building. This protective device or lightning arrester is ordinarily a gap in a vacuum. If lightning should strike the aerial, it would jump the gap and go harmlessly into the ground without damaging the receiving set or possibly starting a fire. There are several commercial varieties of protective devices on the market and these usually come in two styles, one for inside and the other for outside use.



Vacuum gap lightning arrester

The lead-in wire must be brought into the building through a "non-combustible, non-absorptive insulating bushing." An ordinary porcelain tube, such as is usually sold with antenna equipment, meets this requirement.

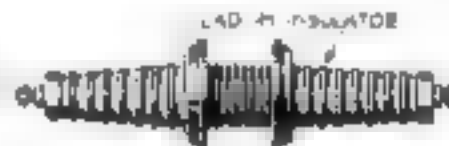
The bushing shown is one of the more expensive types, made of molded composition insulating material.

Aerial, lead-in, and ground wires must not be smaller than No. 14 B. & S. gage or approved No. 17 B. & S. gage copper-clad steel. The ground wire must be connected



GROUND CLAMP

For permanent installations



LEAD-IN INSULATOR

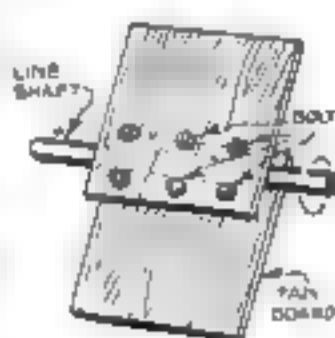
with a permanent ground, preferably a water pipe. An approved ground clamp is required for connecting wire to pipe.

It is most important that all wires used in the installation be kept well away from wires carrying current for light and power purposes.

An outside ground is no longer needed and the use of an antenna ground switch while desirable, is not required and does not obviate the necessity for an approved protective device.—M. F. L.

Ventilating Fan on Line Shaft

IN HOT, humid weather, when a shop is almost unbearably close, the air can be stirred up by improvising a fan in the manner illustrated. Two boards are clamped at a convenient place to the line shafting and revolve with it. H. F. B.



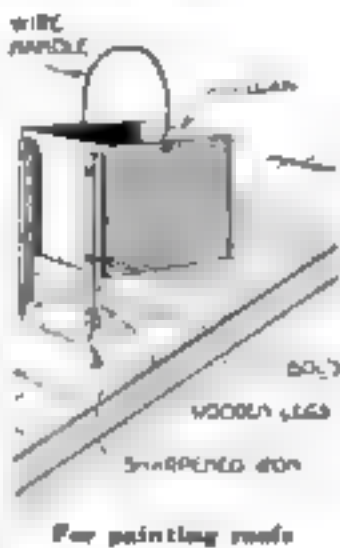
Two boards are bolted to the line shafting and revolve with it, fanning the hot stagnant air into motion.

THE HOME WORKSHOP

This Paint Pot Will Stand Level on a Pitched Roof

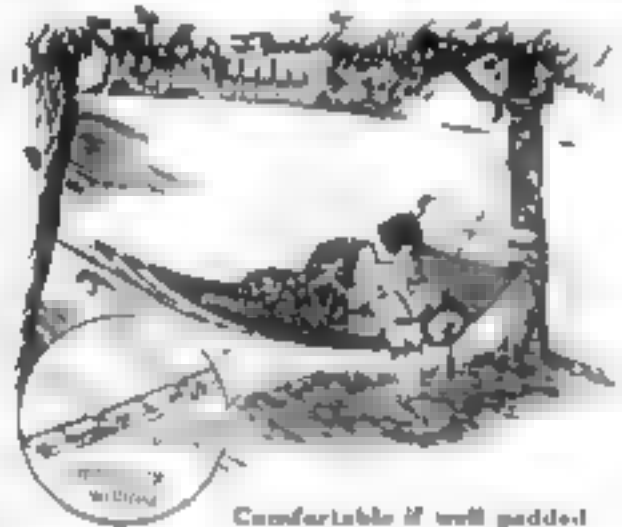
IN MY thirty years' experience as a painter I have never used a better device for holding paint while working on a pitched roof than that illustrated. It saves the trouble of packing around a roofing jack.

Cutting off a common five-gallon oil can 10 in. high, I fastened two legs, 1 by 1 by 16 in., to it with stove bolts. Small sharp pieces of iron are fastened to the legs.—LOUIS L. LYMAN.



Makeshift Hammock from Wire and Barrel Staves

WHEN an ordinary hammock is not at hand, for rough use a makeshift can be constructed from wire and barrel staves as shown. Six pieces of wire, 10 or 12 ft



Comfortable if well padded

long, a sugar or salt barrel, and two heavy rings will be required.

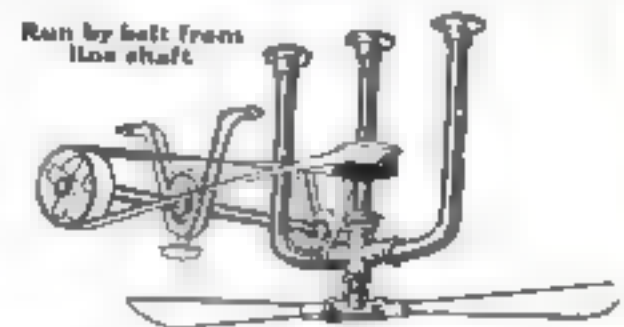
Bore holes about 1 in. from the ends of each stave for the supporting wires to run through.

Another pair of wires is used to hold together the staves at the center, but there no holes are necessary. The staves should be spaced about 2 in. apart.

The hammock should be well padded with cushions or with old blankets, and if the latter are used, they can be neatly covered with burlap.—CHESTER COOPER.

Try This Cheap Shop Fan

DRIVEN from the line shaft, this fan adds greatly to comfort. The fan framework and bracket are made from pipe



fitting. An old ball bearing is placed between collar and lower fitting, which should be babitted. The fan blades are of wood.—S. E. G.



1,820,000 Telephones Moved

In the telephone business every day is "moving day." Telephone subscribers are probably the most stable and permanent portion of our population; yet during the past year one telephone out of every seven in the Bell System was moved from one place of residence or business to another at some time during the year.

The amount of material and labor, and the extent of plant changes involved in "station movement" are indicated by the fact that this item of service cost the Bell System more than \$15,000,000 in 1921.

To most people, the connecting or disconnecting of a telephone seems a simple operation of installing or removing the instrument. As a matter of fact,

in every case it necessitates changes in the cables and wires overhead or underground. It also necessitates changes in central office wires and switchboard connections; in subscribers' accounts and directory listings; and frequently requires new "drop" lines from open wires or cables.

The problems of station movement are among the large problems of the telephone service. Because of the double operation of disconnecting and re-connecting, the work involved is often twice as great as in the case of new subscribers. With nearly 2,000,000 changes a year, it is only by the most expert management of plant facilities that Bell service is enabled to follow the subscriber, wherever he goes.

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AND ASSOCIATED COMPANIES

One Policy, One System, Universal Service, and all directed toward Better Service

HOW TO CONDUCT A RADIO CLUB

E. E. Burkh

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148 pp. Fully illustrated. Price 15c

POPULAR SCIENCE MONTHLY

225 West 39th Street, New York City, N. Y.

PRACTICAL AMATEUR WIRELESS STATIONS

This book contains suggestions of thirty-three expert operators on building, installing and operating experimental stations for radio communication.

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POPULAR SCIENCE MONTHLY

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NEW RADION HARD RUBBER Panels and Parts

RADION Hard Rubber resists warping Preferred for high-class sets.

Radion Hard Rubber is a new material which is superior to all other materials for the construction of radio sets. It is a hard, durable material which does not warp, and it is easy to work with. It is the best material for the construction of radio sets, and it is the only material that can be used for the construction of radio sets.

Dealers write your jobbers at once for information or

American Hard Rubber Company
11 Mercer Street New York, N. Y.

Radium now in Everyday use



"NITELITE STORAGE BATTERY OF LIGHT"

ONE ounce of radium is valued at \$1,260,000. In the world there are only 3 ounces of Radium extracted, yet the universe is saturated with radiations. In comparison with these radiations, the trains of wireless waves veiling our globe are negligible. The enormous energy dissipated in radiations has been harnessed in—NITELITE.

A small battery of NITELITE contains millions of crystals, each a vital, fully charged storage battery. These batteries release their energy in the form of light under the action of radiations and Radium impulses.

This precious material NITELITE is now available for illuminating scores of articles in everyday use.



In the home



Outside the home

uses for NITELITE. Paint the house numbers with it—a wonderful substance. Use it on the door knocker, wash button or bottom step—you have a light that will last for 10 years. From a nickel to a dollar NITELITE is at your service.

On your car, put it on the speedometer, the clock, the gauges on your dash. NITELITE has been prepared in such a simple form that anybody can use it—and it lasts for 10 years. The NITELITE set, with its Radium element, costs only \$1.00. The set contains enough NITELITE to illuminate all the objects you wish to locate in the dark. The set includes simple instructions for the efficient application of NITELITE, also a complete and interesting story of the development of the Radium industry.

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What a Loop Aerial Can Do

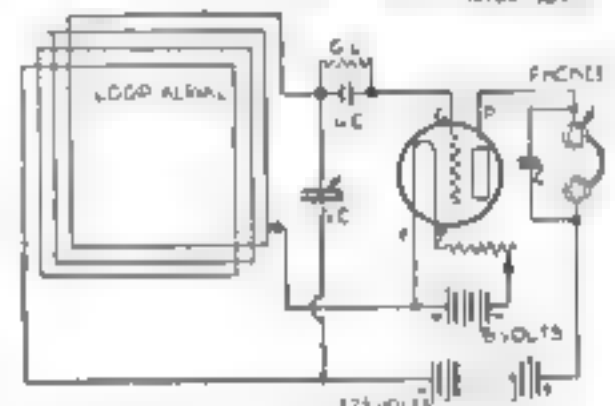
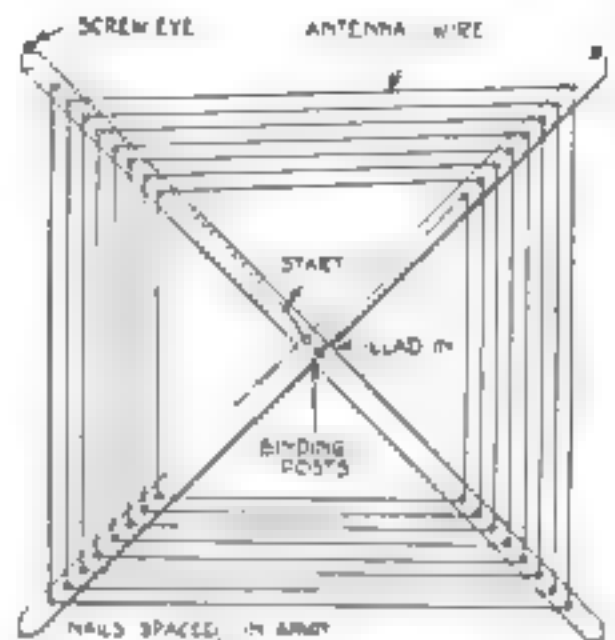
By Stillman Taylor

(All radio authorities are agreed that a loop aerial cannot be used with a crystal set. In spite of that, Mr. Taylor, who is a sporting writer of national reputation, has had remarkably good results in New York City, where radio reception is particularly difficult, with a crystal set and a loop aerial. He used in his experiment, however, super-sensitive pieces of mineral with a universal detector stand holding six crystals in separate chucks, and a set of the finest mica diaphragm telephones made.—THE EDITOR)

WITH a portable crystal receiver and a loop aerial of my own construction, I can bring in the Newark, N. J., station, WJZ, clear as a bell at my desk in an apartment on the top floor of a five-story house in the heart of New York City. By using a vacuum tube detector and a mica super-sensitive receiver, I can tune in WGY at Schenectady, N. Y., and by holding the receiver to the diaphragm of a phonograph, that station can be heard clearly in the room. I can also hear WJZ by making connections with the electric bell circuit that runs through the house, instead of using the loop. This shows that no one living within a reasonable distance of any high powered broadcasting station need be denied the pleasure of listening to the broadcasting.

To receive from a distance with a loop aerial, at least a two-stage amplifier set is essential, but to offset that the loop has marked advantages in its simplicity, its compactness, its cheapness, and its directional characteristics.

The two wooden bars that form the framework are straight pieces of any easily worked wood, such as pine or basswood, each 3 ft. long, 1 in. wide, and $\frac{1}{2}$ in. thick. This is about as small as a loop can be constructed to fulfil its mission. After the two strips are neatly fitted together in the center by a halved joint, the nails are driven partly in, as shown. Common roofing nails may be used and covered with two coats of rubber cement paint or asphaltum. Space the nails 1 in. on centers and screw to the ends of the bars' eyes for suspending the aerial.



How the loop was constructed and hooked up to a simple vacuum tube

Almost any kind of bare copper or aluminum wire may be used, about 1 pound of No. 14 copper will serve. Use binding posts with screws long enough to reach through the spreaders and hold them firmly together.

While a number of different hook-ups are in use, I have found the one illustrated satisfactory when using a vacuum tube detector without amplifiers, but I am satisfied with a low and clear quality of tone in signal. I like quality; but if strong signals are desired a two-stage amplifier should be connected in the detector circuit.

Ice Water from Mountain Spring Heated for Camp Shower

THIS outdoor shower bath was built by one man in less than a day.

The spring water, ice cold, is led by a trough to the heating pan. The pan was made by pounding flat a 5-gal. can, turning

neath the pan heats the water as it runs to a small hollow. From there it is led through a 20-ft. length of 1-in. pipe to the arborlike shelter.

Wired to the end of the pipe is a perforated tin can lid. A cork closes the end of the pipe when not in use.—E. R. SMITH



An open fire warms the water

up the edges on three sides, and bending the pan diagonally, so that the water ran around the edges, as it were. A fire be-

Thumbtack Hammer and Lifter

A MOST useful tool for the draftsman and artist is a thumbtack hammer and puller, made from an old screwdriver. The blade should be bent as shown and slotted to form the lifter; it can also be magnetized to pick up tacks if desired. The handle is bored out and a hardened steel core inserted. This should project $\frac{1}{2}$ or $\frac{3}{8}$ in. so as to serve as a handy hammer. C. C. S.



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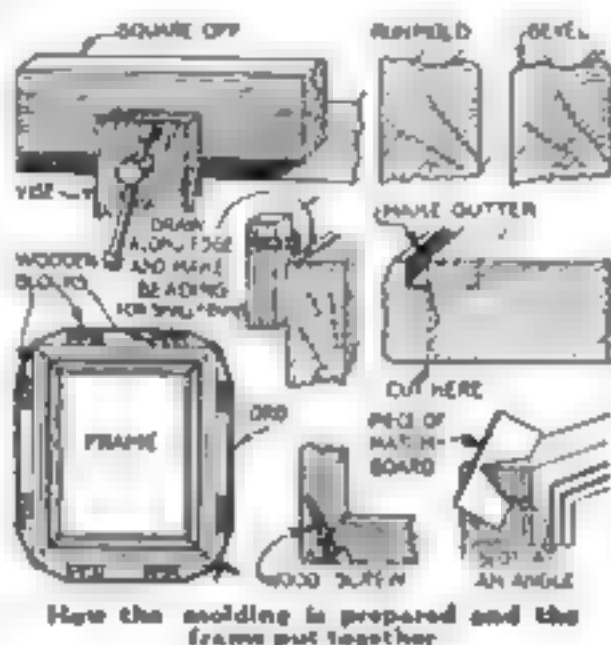
THE HOME WORKSHOP

Making a Picture Frame from Odd Pieces of Wood

By William G. Patrick

THE most profitable use I have found for odd pieces of wood left after cutting up boards is in making picture molding. The usual method would be to cut strips, square up all the edges, stick on the molding, and finally make the rabbet, but I have found the following method to be quicker.

True up both sides of the board, place it in the vise and square off the upper edge. Then run on the molding with a molding plane and bevel the inside edge. Place the board on the bench and with a plow or match-plane take out a gutter of sufficient depth to hold the glass and picture. Then saw off the completed strip, as shown by the dotted line in the right-hand center detail of the illustration. The process is then repeated in exactly the same way to



make other strips of molding. With a little practice one becomes very quick at this method.

Next, the strips of molding are mitered at the correct length. Knot a loop of string that will fit around the frame and place two wooden blocks on each side, as shown in the lower left-hand detail. By moving the blocks toward the ends, the string will be tightened all around. If the frame doesn't fit well together, trim off the mitered ends on a shooting board and try again. When the joints fit perfectly, glue them and clamp the whole together with the string and blocks until dry.

The next thing is to reinforce the joints in some way. In most cases nails are used, but screws, especially for large frames, will hold better. First drill a hole the size of the screw head into the frame about $\frac{1}{4}$ in. deep, as shown, and drill a fine hole in far enough to prevent the screw from splitting the wood.

For small frames an easier way is to make a cut with a fine tenon saw in the corner of the frame for about $\frac{1}{4}$ in. at an angle of about 45 degrees, as shown. Glue a small slip of wood in the cut and when it is dry cut off the surplus.

Molding for very small pictures may be made by running beads along a piece of wood with an improvised plane made by setting a screw into a block of hard wood about $\frac{1}{4}$ by 2 by 3 in. A touch of sandpaper will take off any rough edges.

When stained, frames made in this way often look better than commercial plaster molded ones and are far more substantial.



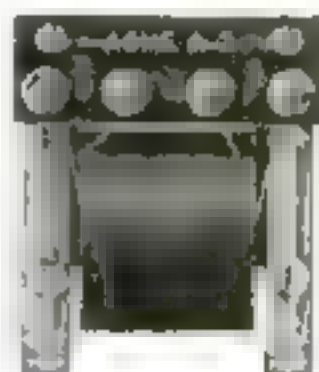
"Stop those back fence concerts"

THE yowls of a prowling Tommy are as mere love-songs beside the ear-splitting howls of a perturbed radio set (and you'll be surprised how often one gets perturbed without the calming influence of the proper Amplifying Transformer).

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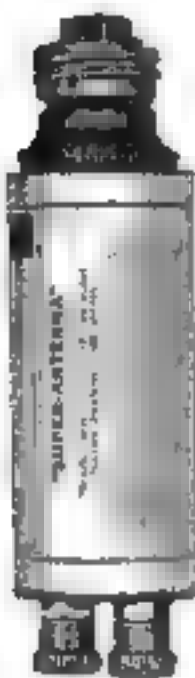
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How to Adjust Negative Voltage of Vacuum Tube Grid

By Arnold Holman

TO GET the best results from a vacuum tube receiving set, it is necessary to have the grid potential properly adjusted. Every radio enthusiast who is interested in understanding the why's and wherefore's of his apparatus should be familiar with the various methods for biasing the audio grid positively or negatively, as the case may be.

The simplest method is to bring the grid to the proper potential by applying a battery of the correct voltage directly to it.

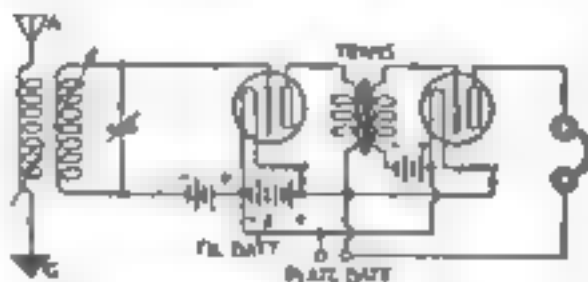


Fig. 1. Applying battery directly to gold

as in Fig. 1; but this is not convenient in all cases. A single circuit may require a number of different potentials. A single battery may, indeed, furnish negative potential for a number of parts of a circuit if the grid in question is provided with a by-pass of sufficiently low impedance for the frequency of the current flowing through it. Usually a large condenser is used. Figure

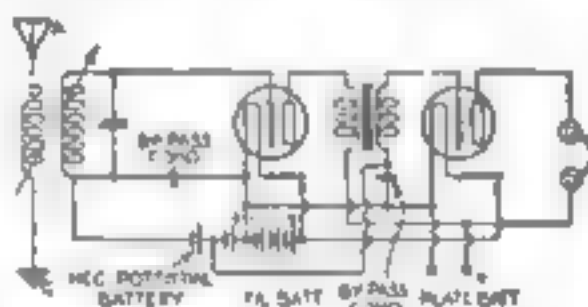


Fig. 2. Varying the negative grid potential

2 shows conditions where more than one value of negative grid potential is required

If we do not want to use batteries for negative grid potential and can afford to waste some filament power in resistance,

the voltage drop across the resistance may be used. Taps on this resistance afford different voltages for various uses. A variation of this method is to connect the audione

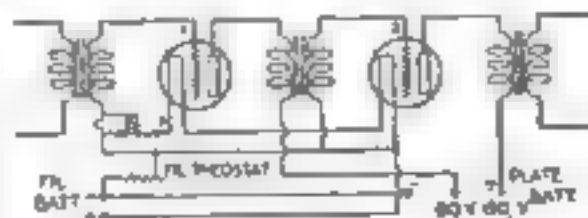
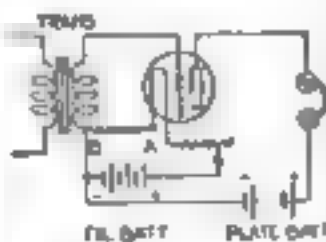


Fig. 3 (above) and Fig. 4 (below) show methods of utilizing voltage drops elsewhere in the circuit.

in series and utilize the drop in potential across some of the audions to furnish the proper negative grid potential. These methods are illustrated by Figs. 3 and 4.

A method utilizing the filament battery is to shunt it with a resistance high enough to draw but a fraction of the filament cur-

(Continued on page 94)



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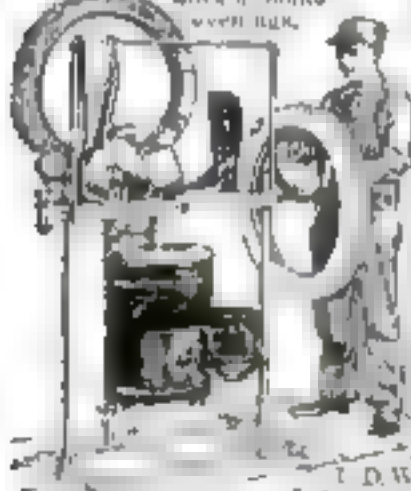
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How to Adjust Negative Voltage

(Continued from page 93)

rent and tap it at the appropriate places. The voltage at any tap will be in the same ratio as the resistances. For example, suppose 3 V. T. 1's connected in series are

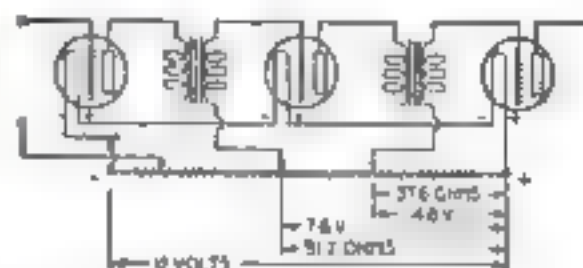


Fig. 6. Using a variable resistance across filament battery

operated from a 12-volt battery and that their filament current is adjusted to 1.16 amperes (Fig. 5). The voltage drop across each tube will be approximately 2.8 volts. Now connect a 144-ohm resistance a, b, across the battery. The current through this resistance will be half an ampere

$$\left(I = \frac{E}{R} = \frac{12}{144} = \frac{1}{12} \right)$$

and the energy consumed is 1 watt ($P = IE = 12 \times \frac{1}{12} = 1$).

Now, suppose it is desired that grid No. 1 should be two volts negative with respect to the negative terminal of the filament of V. T. 1, No. 2. The taps should be 2.8 plus 2 volts, or 4.8 volts negative to the positive terminal of the battery. Then by direct proportion we can find the value of the resistance at which a tap must be taken—4.8 volts: 12 volts:: x ohms: 144 ohms. Solving $x = 57.6$ ohms from the positive terminal.

In the same way, if grid No. 2 is to be two volts negative, then the tap should be 2.8 plus 2.8 plus 2 volts from the plus terminal of the battery. Solving in the same way—7.6: 12:: x: 144, or $x = 91.2$ ohms.

Still another convenient method is to make use of the drop in a resistance in the

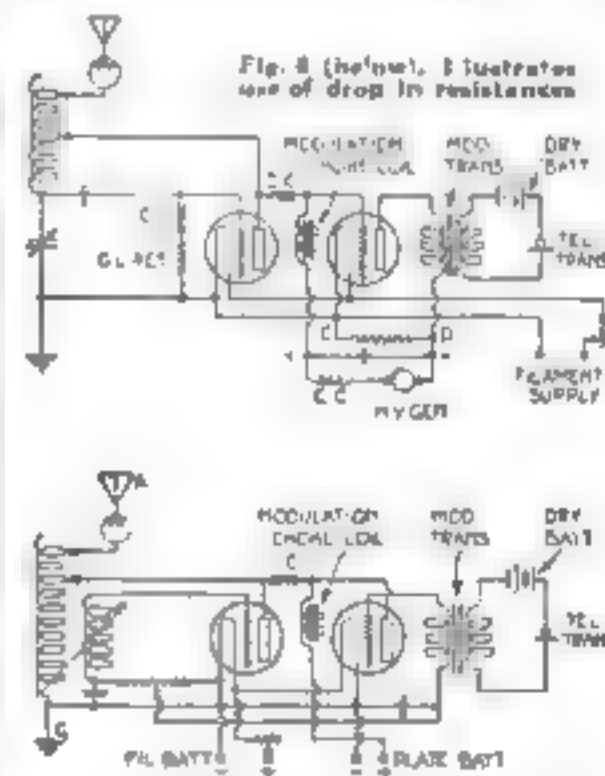


Fig. 7 (above). Shows method of tapping a grid leak

negative lead of the plate supply. This is very convenient in radio transmitters. Figure 6 is an example of such an arrangement used for the production of negative grid potential. The current flows from terminal C to D of the resistance so that point D is negative with respect to C by

(Continued on page 95)

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THE HOME WORKSHOP

How to Adjust Negative Voltage

(Continued from page 94)

an amount that is equal to the current flowing, multiplied by the resistance ($E=IR$, Ohm's law).

In most audion transmitters a grid leak is used to limit the current that can flow to the grid and at the same time provide an automatic negative potential for the grid of the oscillator. This negative potential is equal to the value of grid current flowing, multiplied by the resistance of the grid leak.

If the negative potential desired is not more than that generated, it can be obtained by tapping the grid leak at the proper point. Figure 7 is a circuit diagram showing how this negative grid potential can be utilized.

It is hoped that these methods of supplying negative grid potential may be helpful to the experimenter. They all have found application in radiotelephone, telegraph and buzzer, modulated transmitters and detectors used by the United States and British armies and navies and by various commercial companies.

"Listening In" on the Radio
Phone with Stethoscopes

AMONG many schemes that have been devised to permit several persons to listen to radio broadcasting without purchasing several sets of telephone receivers or a loudspeaker, one of the most inexpensive is by means of stethoscopes.

One of the head phones is mounted on a wooden base block and on it is placed a small tin can with the top and bottom cut out. A mason jar ring serves as a gasket. The other phone is placed on top of the tin cylinder with another gasket, and the whole is held together with springs or rubber bands so as to form a tight sound chamber.

Tubes are soldered into the can to provide as many outlets as desired, and with them are connected, by means of rubber tubing, the stethoscopes. Those from old fashioned phonographs can sometimes be picked up, or stethoscopes may be constructed with ear pieces and connections made from glass tubing, shaped with a Bunsen burner or an alcohol torch. These connections may even be whittled from wood. —C. B. SANFORD.



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IF THERE is any doubt about the quality of the ground connection, it will pay to purchase a bag of charcoal and dump it around a copper plate or section of wire netting, whichever you prefer for your "ground," buried six feet in the earth. The charcoal attracts moisture and assures a good ground for a radio set even in dry soil.

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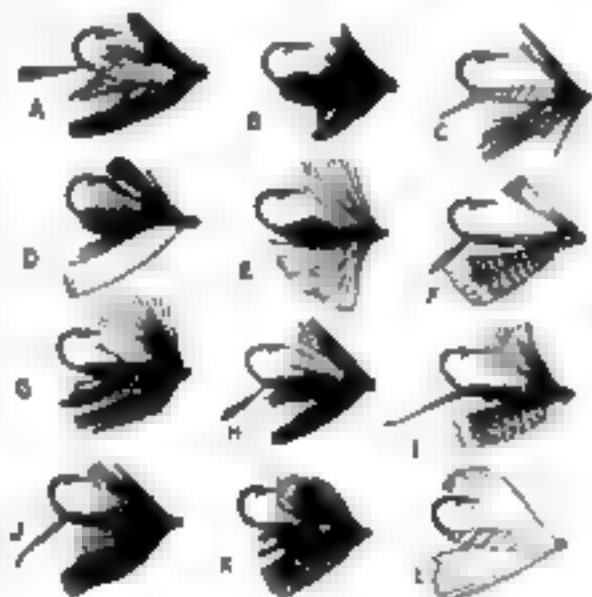
Fly Casting Equipment

(Continued from page 80)

is no projecting handle to catch the line. This form of reel in a 60-yd. size will be found about right for the average fly rod.

A waterproofed, enameled silk line is the most suitable one for fly casting. One in *F* size will be found plenty large enough, and nothing larger than size *E* need be used. Twenty-five yards of line are ample. When selecting see that it has a hard surface, with a flexible enamel; one that is pliable but does not feel sticky. A light colored line will be found less conspicuous in the water, so avoid the black and dark brown and green lines. You can test this yourself by immersing a short length of different colored lines in a glass of water. A good line will last for several seasons of average fishing, if kept well greased with mutton tallow and not stored away tightly wound on the spool of the reel.

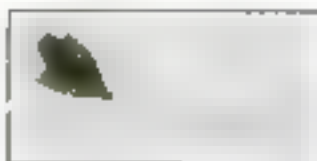
There are many different patterns of artificial flies. While no two anglers are likely to choose the same flies, every fly caster of experience will include in his outfit a collection of standard patterns. For a beginning, the angler does not need over a



dozen patterns, and my experience suggests the following flies as the most killing. These are standard and stocked by all dealers.

- | | |
|----------------|----------------------|
| A—Heavenkill | G—Cowling |
| B—Lower Hackle | H—Vase Brown |
| C—Caddis | I—Pheasant |
| D—Caddisman | J—Minnow |
| E—Dry-die | K—Queen of the Water |
| F—Grasshopper | L—White Miller |

The "reversed wing" fly is mostly used, and this is made by sliding the wings on the hook parallel with the snell, or eye. After the hackle is tied on, the wings are reversed to point in the direction of the barb. This way of tying the fly is firm and durable, and will stand a great deal of hard use. The "matched wing" or "fluttering" styles are more dainty in appearance; this fly is tied on a single length of gut called a "snell," and is reinforced with a short piece of gut near the hook, known as a "helper." The snelled fly is attached to the leader without knotting. Simply pass the loop of the fly through the leader loop, and pass the fly through the loop just formed, in slipknot fashion. Like the leaders, snelled flies should be kept moistened beneath the felt pads, and carried to the stream in this condition.



Fastening snelled flies to leader

(Continued on page 98)

BRISTOL LOUD SPEAKER

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"AUDIOPHONE"

Patents Pending

For Radio-Phone RECEPTION

NO BATTERY REQUIRED

NO DISTORTION OF
MUSIC OR SPEECHBell
15-inches
Handsome
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Remarkable for its rich, natural and clear tone, the Bristol Loud Speaker "AUDIOPHONE" reproduces songs, instrumental music, speeches, announcements with a greater audibility than is possible with other radio receivers. This is possible because of the special design of bell and neck, and the electrical characteristics of the receiver box, together with the materials used.

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The "AUDIOPHONE" makes an attractive appearance in any room, in the home, club, hotel, etc.

If you cannot obtain Bristol Loud Speaker "AUDIOPHONE" from your local dealer we can arrange for it, or supply you direct, as desired. Write our nearest office.

Bristol Loud Speaker "AUDIOPHONE" \$40.00
Firm, list price

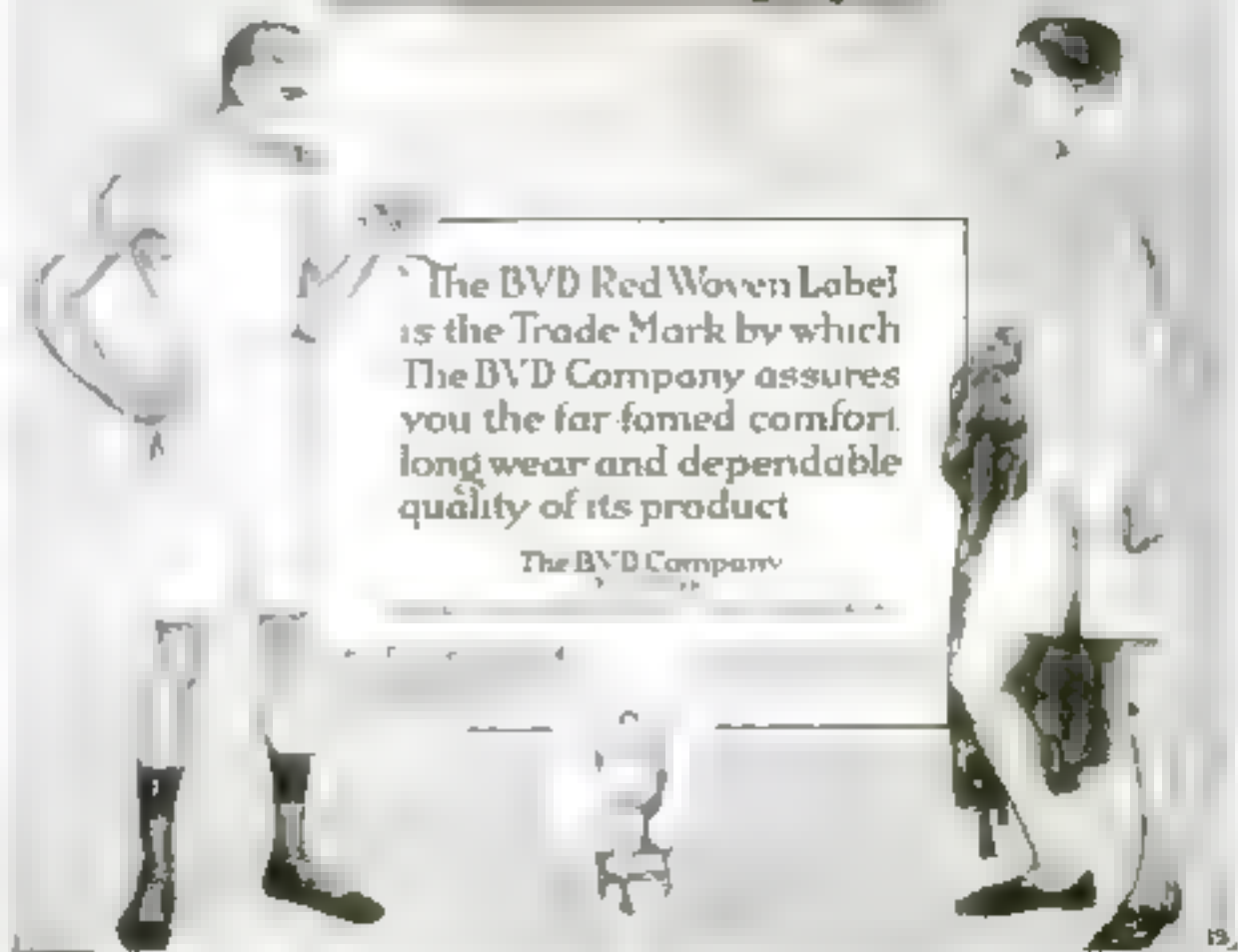
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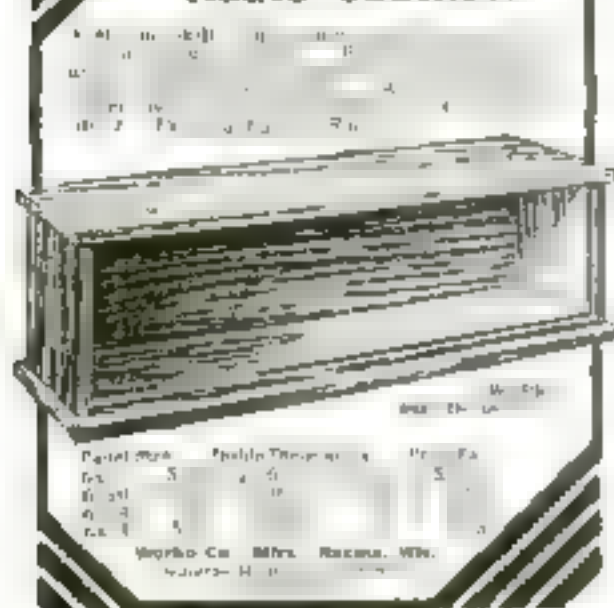
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WORKO Radio Cabinets



THE HOME WORKSHOP

Fly Casting Equipment

(Continued from page 97)

use the leaders and flies should be dried out and replaced in the fly book.

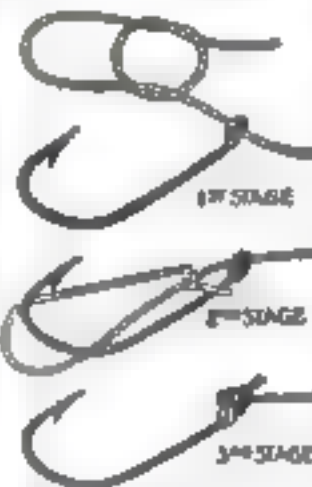
The eyed fly—that is, a fly tied on eyed hooks—has many merits. It may be used with a snell or knotted directly to the leader, and need not be discarded until it is worn out. Most of the larger tackle dealers carry all standard designs of flies in different hook sizes on eyed hooks. The eyed fly is attached to the leader with the common jam knot, which makes a strong and neat knot when pulled tight.

What size hook to use depends upon the size of trout one fishes for. Flies tied on No. 8 hooks are the standard, but No. 6 are often used for northern streams where the trout run to a large size. Nos. 10 and 12 are used for small brook casting.

A skillful fly fisherman uses a fine leader, and the common-sense rule is to have the leader with a breaking strain much less than that of the line. For length, a single gut leader measuring $2\frac{1}{2}$ ft. is sometimes used, but a 5-ft. leader is better for all but small brook casting. Longer leaders, of course, are used, up to 12 ft., but these are only an advantage when casting on large streams. For average use, a long leader is likely to catch its loop in the top ring of the rod when reeling in the line to bring the trout within reach of the short-handled landing net.

You can buy leaders ready made, with loops tied in for using two or three flies. More than two flies are never necessary, and the more skillful casters prefer to use a one-fly cast. Stained or dyed gut of a gray or rust color is often used, because the angler regards it as less conspicuous in the water. This is contrary to my own experience, and after experimenting with many shades, I prefer the original color of the natural unbleached gut. Get a round, aluminum leader box, moisten the felt pads, and put your leaders between them.

A landing net of some kind is well worth carrying, even if it is sometimes in the way when going through the brush. The regulation fishing basket or creel is made of willow, and the best kind is provided with metal hinges and fastening for the lid. The hole should be on one side rather than in the center, and the best strap is the usual shoulder strap and an additional strap of webbing, which goes across the breast. When one is stooping over, this prevents the creel from shifting around in front.



Jam knot for eyed flies



Fastening leader to line



Creel and landing net



Jimmy's Diary

Tuesday, June 27

"Won a bike race today. Ted Barnes said he could beat me. Raced to Nicholson's Farm on the highway—two and a half miles.

"Pretty close, I'll say. Old Ted might have won only he got a puncture in sight of the finish and the flat tire slowed him up.

"I didn't have to worry. Had good old Neverleak Tire Fluid in my tires. It stops almost any leak."

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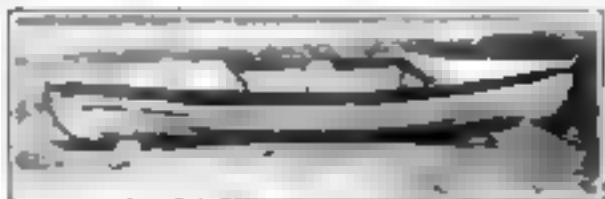
How to Build Stanch Canoes at Little Cost

By Gilbert P. Cham

Lieutenant-Commander U. S. N., Retired

IT WAS in the summer of nineteen-twenty, just after I had retired from active service in the Navy, and we had settled in Mountain Lakes, N. J. Of course the boy wanted a canoe. I wanted him to have one, too. But prices were high, frightfully high in those days. Seventy-five dollars for a canoe with the summer half gone had not a cheerful sound.

While we were considering what to do, the boy found out that other boys around the lakes were making canvas canoes. Furthermore, these homemade boats were more popular than the store canoes because of their lightness and the ease with which



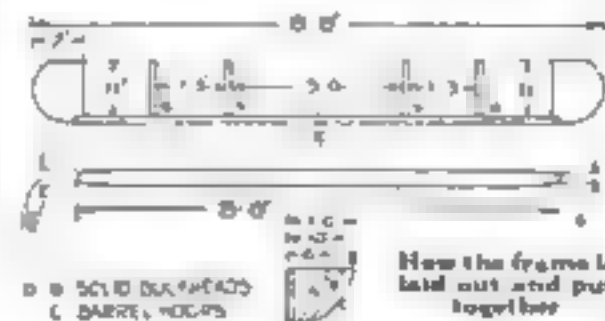
This trim little canoe sits on the water like a duck

they could be moved about and paddled. My son got the idea, assembled his materials, and started in.

After he had the two end pieces fastened to the keel, he called on me for advice and assistance. According to the specifications the ribs were to be barrel hoops, but I am a great believer in the solid bulkhead, so suggested that we use the ends of boxes.

Finding that the owner could accommodate himself in a cockpit 3 ft. long, I set two bulkheads 3 ft. apart on the keel, equidistant from the midship section. A "collision bulkhead" was set 15 in. from each of these.

For the longitudinal we used thin strips of pine, and a barrel hoop for stiffening the midship section. By this time the boy in the next house had become so much inter-



ested in the shipbuilding operations that he was taken into partnership.

With the photographs and sketch, a detailed description is unnecessary. The construction was varied somewhat in later numbers, as by using hoops instead of solid bulkheads. Altogether, my son made three canoes. The first one he still has; the second was sold, and the third was given away.

Before putting on the first coat of paint, the canvas must be wet. It is not necessary

(Continued on page 100)

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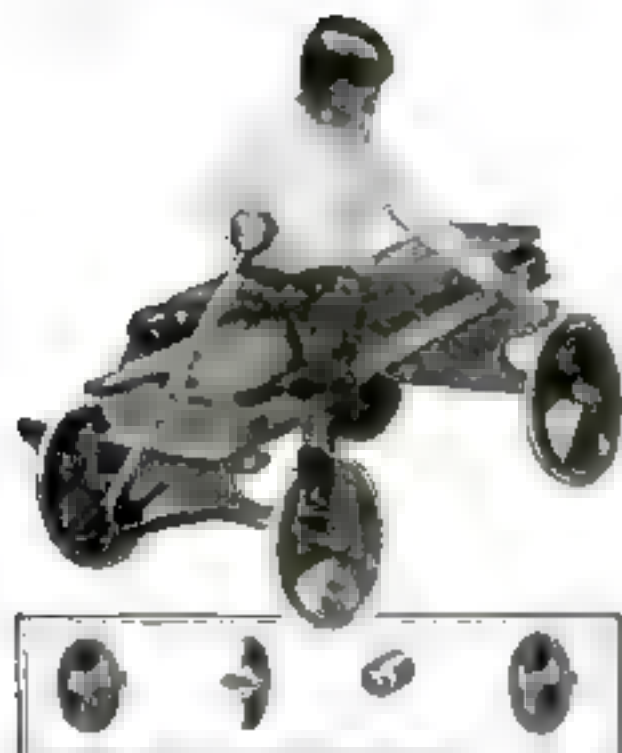
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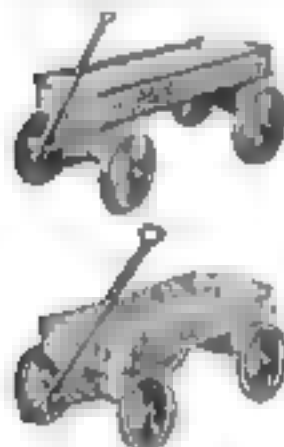


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**A paddling cat lends a helping hand
to a lone animal.**

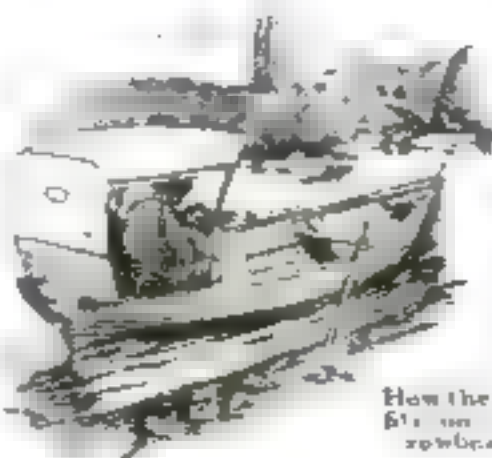
is 4 by 5 ft., and 2 in. is allowed on all sides for turning over. All the rope is 3.16 in. in diameter, and the sheet rope is 9 ft. long.

Through the five brass grommets on the mast side are passed rope loops. Four of them are 3-in. loops and are slipped over the mast, which is 2 in. in diameter and 7 ft. long. The upper loop is 6 in. long and is passed through a slot at the top of the mast, slipped through a loop in the short paddle tie rope, and placed over the top of the mast. The paddle tie rope is then brought down, and the lower end, which is "forked," is passed around the mast and through two 3/4-in. holes in the paddle blade. The ends are then tied in a bow.

The sail is fixed to the other end of the paddle by slipping a 6-in. loop through a 1½-in. hole and passing it over the end of the handle.

The sail may be made waterproof by giving it two coats of boiled linseed oil to which a little turpentine has been added—HENRY S. LARABY

Sun Top Improves Rowboat



How the Imp
for the
project

A DISCARDED buggy top or even the top from a small automobile will make a good sun top for a rowboat. It can be fastened in place with strap iron.—L. B. ROBBINS.

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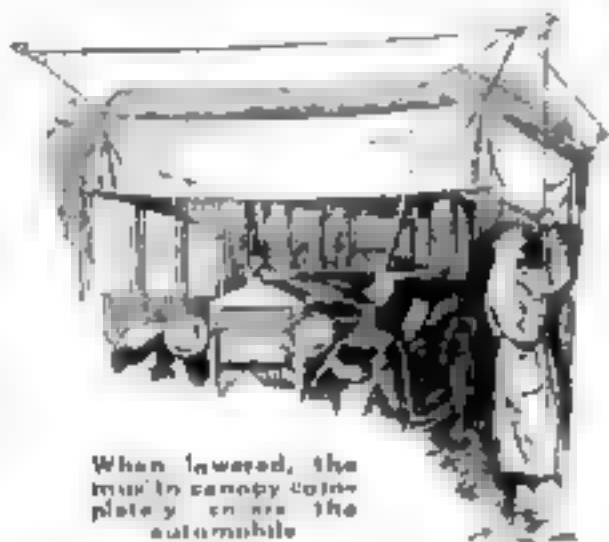
Supply management commitment (in which 2 years were anticipated).
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THE HOME WORKSHOP

Easily Handled Muslin Covering Protects Automobile from Dust

IT IS a tight garage that keeps out sifting dust and sand particles. In the Middle Western states, where dust-laden air is common, a car will soon be covered with dust, even in a tightly built garage. If the finish is in good condition, the chances are that it won't remain so, unless some extra care is taken.

The illustration shows the method used by one car-owner to prolong the luster on



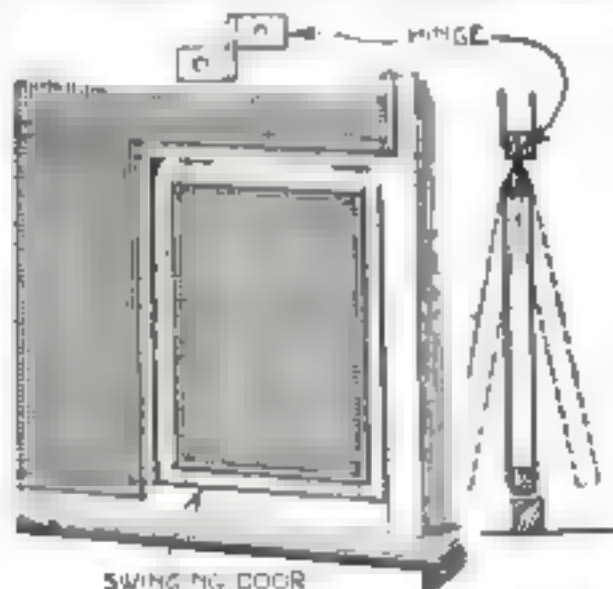
When lowered, the muslin canopy covers the automobile.

his car. A muslin sheet 8 ft. larger each way than the dimensions of the plan of the car, was sewed together and arranged over the garage floor by sewing loops in the sheet, at 2 or 3 ft. intervals from the corners of the cloth. Small trunk ropes were tied to these and in turn run over pulleys made fast to plate ties overhead and spaced close to the sides of the garage. These ropes were then dropped to the floor and wrapped about a spike in a convenient studding to hold the sheet in place overhead.

When the car is driven in, the ropes are loosened and the sheet let fall over the car, completely enveloping it. Later, the four ropes were all run through a single pulley and twisted slightly to form a cord. Then, by simply operating one rope, the sheet was adjusted. — N. M.

Swinging Screen-Door Designed for Pet Cat or Dog

A SWINGING door as shown here was set in the screen of our back window to accommodate our pet cat. She pushes it open with her nose and paw, thus going in



SWINGING DOOR

Pussy can come and go as she pleases through this screen.

and out as she pleases. The device helps considerably in keeping the house free from flies. It could be put in a screen-door as well as a window. — D. W. CLARK

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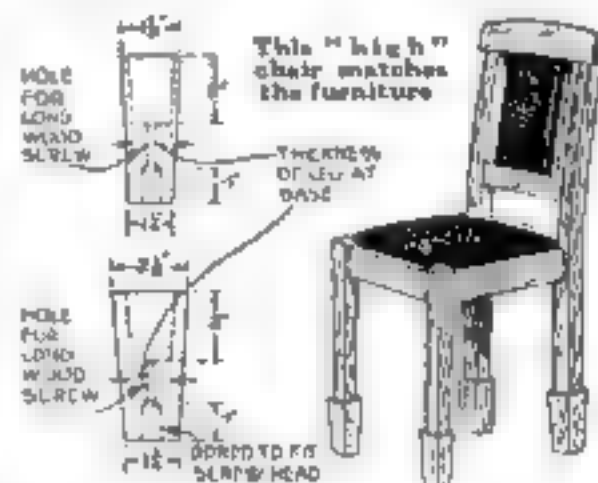
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THE HOME WORKSHOP

Four Blocks Raise Dining-Chair for Child's Use

TO RAISE a dining-chair high enough for a child of 2 1/2 years and older, four blocks about 6 in. long may be made and screwed to the legs as shown in the accompanying illustration. The advantage of this method is that the chair then matches



the others in the dining-room. When the blocks are no longer needed, they can be removed by taking out the long screws.

The blocks should be made of hard wood carefully shaped, sandpapered, and stained or polished to match the wood finish of the chair.—HARRY R. L. CHELSEA

Make Money with Your Camera

OUT in San Bernardino, Calif., a wide-awake man stood watching two workmen as they laboriously heaved a great bale of straw over the tailboard of a truck. What he saw gave him an idea. Why not save the labor of one of those men, and at the same time make the job easier?

He developed his idea, and the result was a tailboard elevator, driven by the truck motor, that lifts thousands of pounds to the level of the truck floor.

There was another wide-awake man, in Riverside, Calif., who saw the truck in operation. He, too, had an idea. He got his camera in action and photographed two views of the tailboard elevator—pictures that revealed how it worked. As a result, this Riverside man, C. R. Baldwin, won the

FIRST PRIZE, \$25

in POPULAR SCIENCE MONTHLY's camera contest for August. You will find his winning contribution on page 39 of this issue.

Any reader of POPULAR SCIENCE MONTHLY, by keeping his or her eyes open for ingenious new mechanical devices or scientific achievements, and by watching for a chance to make use of his camera, can, like Mr. Baldwin, win part of the

\$50 in Prizes awarded each month

to readers of POPULAR SCIENCE MONTHLY who send in the most interesting photographs of scientific or mechanical interest.

Other winners in the August contest, whose contribution appear in this issue, are

SECOND PRIZE, \$15—Allen P. Child, Kansas City, Mo. Subject: "Horse and Giant Hammer Pull Stumps" (see page 33).

THIRD PRIZE, \$10—Dan West, The Dalles, Ore. Subject: "Tractor on Stilts Lifts Lumber Pile" (see page 49).

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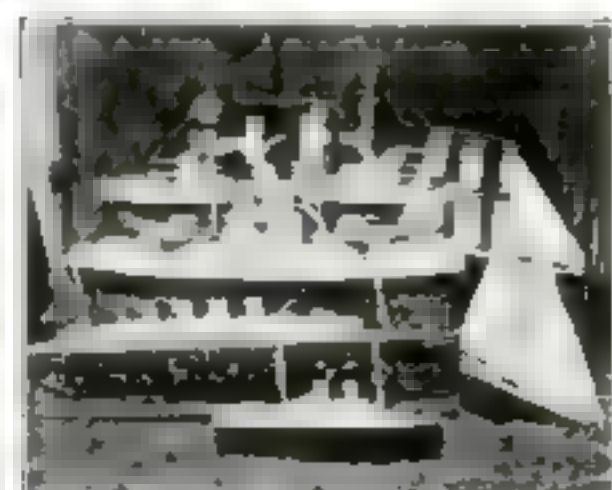
THE HOME WORKSHOP

Furniture and Toys Bring in \$325 in Five Months

By Maynard N. Kirkwood
 (Contributed in the contest, "How I Made Money with My Tools")

MY WORKSHOP is composed of half a garage, partitioned off and floored, with a gas connection for my glue pot and soldering iron, and an electric light for night work. About a year ago when I started to get together a set of tools, I had a saw, hammer, brace, a few bits, and a coping saw. The value of my tools now is \$85.

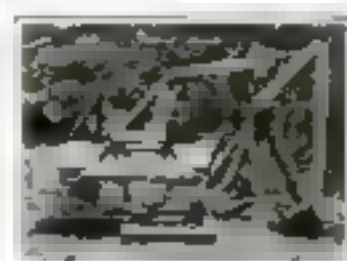
During the past four months I have made on order four indoor flower boxes, two cedar chests, a piano bench, three book-racks, two medicine cabinets, two tool-



Model battleships and steamships that sold for from \$1 to \$4 each

chests, one portable electric table lamp, and a piano lamp. On file I have orders for a library table, a buffet, and a child's bed. In selling these articles I have a certain advantage in that my work as salesman brings me in contact with many housewives and therefore it is very little trouble to get all the work I can handle. I find that by visiting the five large lumber companies in the city I am able to pick up good stock, and by buying it in as large quantities as possible I am able to get a little benefit in the price. I also find it pays to go to planing mills, where there is always a supply of odds and ends of lumber that can be purchased for a small sum.

Flower boxes, which cost approximately \$1.35, sell for \$3; cedar chests, which cost from \$6 to \$10, sell for from \$15 to \$25; a redwood piano bench, mahogany finish, cost \$5.50 and sold for \$11.75. Portable piano lamps of mahogany cost me complete, with silk covered shade on a wooden frame, from \$18 to \$22 and sell for from \$40 to \$50. A buffet I made for myself of walnut with mirrors and leaded glass, cost \$36.15 for materials and finishing, and the same piece in a similar design and materials would have cost me, if bought at retail, \$127.50.



A toy construction derrick

The model steamships and battleships illustrated were made for boys in my neighborhood and brought from \$1 to \$4 apiece. The battleships cost me about \$2 and are made of white pine "two by sixes," 4 ft. long. The superstructure is of light stock. The steamer, which cost \$3 and sold for \$5.25, is made of the same material. The keel of each boat is a length

(Continued on page 106.)

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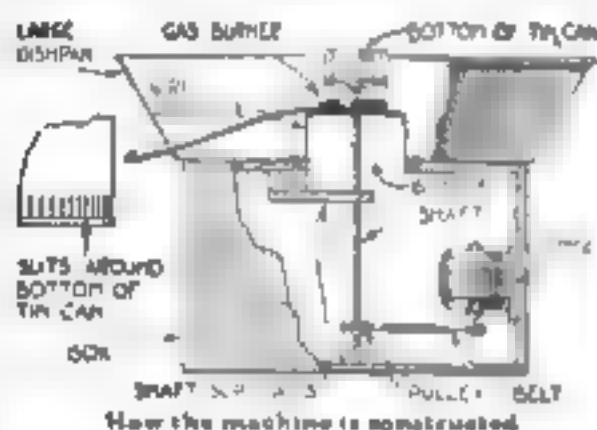
THE HOME WORKSHOP

Homemade Candy Floss Machine
Turns Out Dainty Confection

A TEASPOONFUL of sugar is spun into a large puff of candy floss by the inexpensive and comparatively simple machine illustrated. It has proved a money-maker at small fairs, and a novelty for social gatherings.

A large dishpan with a 6-in. hole cut in the center of the bottom was first mounted on a box and two wire arches were soldered over the opening to support a gas burner. The sugar receptacle was made from the bottom of a baking-powder can, cut off so as to be 2 1/4 in. high. The cut edge was turned down to make a smooth finish.

One-half-in. slits, not more than 1/32 in. wide, were cut at 1/4-in. intervals around



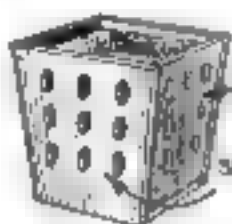
the bottom of the can, as shown. Three were made by pressing a knife blade through the tin and smoothing the rough edges inside. The sugar container was then fastened to a flange at the upper end of a shaft, so that it could be revolved steadily and rapidly by a small motor.

In operation the gas burner is lighted after the motor is started. When the revolving sugar container has become heated, a small amount of granulated sugar is poured into it. When the sugar begins to melt, it is thrown by centrifugal force, in liquid form, through the small slits. As soon as it strikes the cooler air outside, it again becomes solid, only in a form resembling cotton. This is caught on a paper cone, which is revolved until a large puff of candy has been collected on it. The candy can be colored by adding jelly powder of various flavors to the sugar.

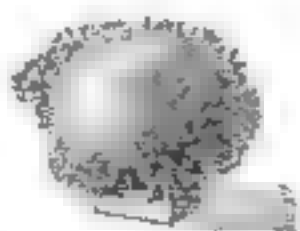
A crank and gear can be used in place of the motor, if electric current is not available. F. C. D.

Growing Ornamental Boxwood

FOR the home gardener who wishes to have ornamental boxwood plants, a good method is to drill holes in the sides of a hopper-shaped box as shown. Little sprouts are planted in these holes with the aid of a sharp pointed stick or dibble. Other sprouts are placed in the top of the box. When the plants have grown, the box will be covered almost completely with the growth of boxwood.—W. C. ROGER.



HOLES FOR SEEDLINGS



Inatures bushy growth

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THE HOME WORKSHOP

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A reproduction of a check made in this way is illustrated. This was printed with a



This print shows even the indorsement.

two-second exposure before a 25-watt lamp. The light passed through the check from front to back, so that the photograph was made in the same way as a blueprint.

It will be noted that this method of making "negatives" has the unique advantage of reproducing simultaneously the matter on both the face and the back of the check. By holding the print before a mirror, or looking through the paper, the reverse writing or printing may be read.

Photographic printing paper may also be used to record the shape and size of important keys. The illustration shows a record of a key to a safety deposit box, and from it a duplicate could be cut if the key were lost. Fences, leaves, lace, certain types of needlework, pierced metalwork, and many flat ornaments



Recording shape of key

may readily be copied in the same way.

Duplicates of unmounted photographs may even be made. The first exposure—a "negative"—must be washed and dried and a second print made from it in order to obtain a "positive" that will correspond to the original. The fiber of the paper will register to a certain extent, so it is advisable to choose a fine grained paper and one that is recommended for use with very flat negatives.—L. P.

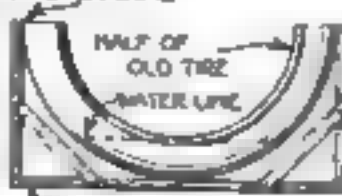
Old Tire Forms Testing Trough for Automobile Inner Tubes

AN OLD automobile tire cut in half can be used as a water-trough for testing inner tubes, provided it is free from holes.

The old tire should be placed, for convenience in handling, in a frame or crate as illustrated. The three boards of the frame should be 3/4 in. thick and 8 in. wide, and should be braced securely by strips across the corners.

The whole trough can be assembled with little trouble and expense, and stored away when not in use.—CHARLES BROCKSMITH.

HALF TO FRAME



For testing inner tubes

Equipment Which Actuates the Man

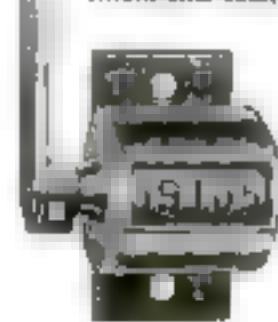
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His production-record on a counter reaches the mind—and moves the hand—of the operator. The only piece of machine equipment actuating the worker, is a

Veeder COUNTER

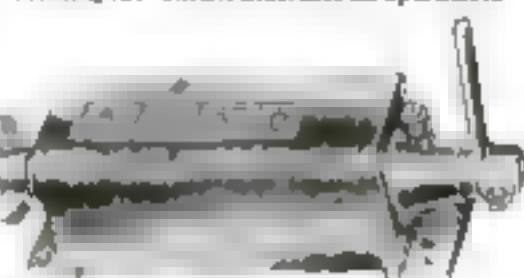
The small Revolution Counter below registers one for a revolution of a shaft, recording a machine operation, or product. Though small, this counter is very durable.



its mechanism will stand a very high rate of speed making it especially suitable for light, fast-running machines, and most adaptable to experimental work. If run backward, the counter subtracts. Price \$2.00. (Cat 4/3 also.) Small Rotary Ratchet Counter, to register reciprocating movements of small machines, also \$2.00.

The Set-Back Rotary Ratchet Counter below is for the larger machines, such as punch presses and metal-stamping machines, where a reciprocating movement indicates an operation.

Registers one for each throw of the lever, and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figures, as illustrated, \$11.50—subject to discount. (Cat less than 3/4 size.) Set-Back Revolution Counter, to count revolutions of a shaft (large model like the above). \$10.00 (list).



There's a Veeder exactly suitable for the type of machine you're interested in; write for free illustrated booklet.

The Veeder Mfg. Co.,
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The Paper Test—

Before the experienced electrician or telephone lineman buys a pair of pliers he tests them with a moist piece of paper.

Pick up a pair of Neverslip Pliers—moisten a piece of paper between your lips and fit it between the cutting blades. Then grip your hands. *Chp!* The paper is cut clean as a whistle. And you can bet your bottom dollar that a pair of pliers that stands the paper test will cut anything from a ten penny nail to the softest wire.

Neverslips cut clean because their cutting blades are made from special high carbon crucible steel. But should you accidentally nick one of the edges it may easily be replaced with a new blade. That's why Neverslips are guaranteed to outcut and outlast any other made.

NEVERSLIP side cutting pliers

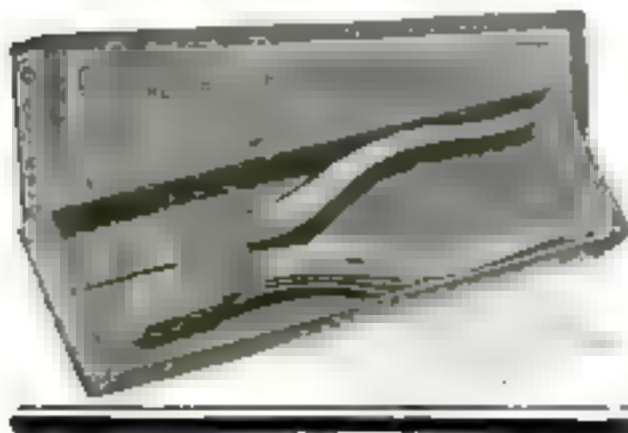
Ask your hardware dealer to show you a pair. If he hasn't them in stock send us his name and we'll see that you are supplied.

Write for Leaflet

THE NEVERSLIP WORKS

New Brunswick, New Jersey

Neverslip Pliers are furnished in six, seven and eight inch sizes

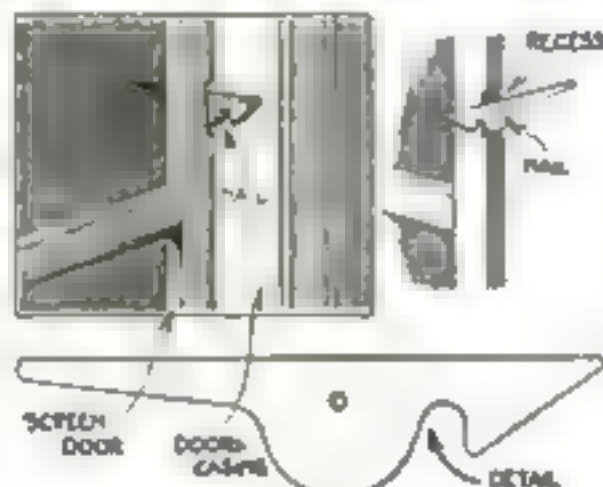


The Shipshape Home How to Do the Odd Jobs

Screen Door Latch

Two latches that worked well all last summer on our screen doors were made quickly and easily from pieces of scrap iron $\frac{1}{4}$ or $\frac{3}{16}$ in. thick, $\frac{3}{4}$ in. wide, and about 3 in. long. The length depends on the thickness of the door.

The catch should be cut out with a hacksaw and filed smooth. It is then fitted into



The shape of the latch and the manner of fastening it to the door

a notch cut in the edge of the screen door and fastened with a nail. Drive another nail in the door casing for the hook to catch.

If there are children in the household, it is advisable to place the latch about 5 ft. from the floor. The children then cannot open the door.

The latching is automatic, that is, provided the hole in the latch is placed far enough from the hook end so that that end will outbalance the handle.—K. W. F.

Painting "Kinks"

PAINT should never be applied to a surface that is not thoroughly dry. Be sure there is no moisture underneath, even if the wood seems free from dampness on the surface.

Do not start painting before the sun has dried up the heavy morning dew. Choose some other time than damp, unsettled, or rainy weather.

A new house should not be painted while the plaster inside is still damp.

Knots and all sappy streaks and spots should be coated with shellac and allowed to dry before the paint is applied.

Three thin coats are better than two heavy ones. See that enough turpentine is added to under coats to reduce the surface gloss, as otherwise the glossy finishing coat will not adhere so well. Allow at least 48 hours between coats.—R. P.

Care of Brushes

WHEN you are through using a brush for painting or varnishing, clean it with turpentine and wash it with ordinary yellow soap and water. Straighten the bristles and wrap them carefully in paper folded in about the same way as the wrapper in which the brush was purchased. Care in cleaning is the chief essential in preserving the brush in good condition.

To keep a brush pliable overnight, suspend it in the paint in which it has been

(Continued on page 111)

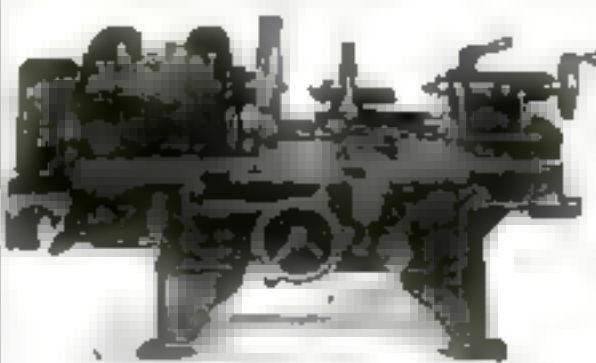
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Gary, Indiana (Post Office, Pittsburgh, Pa.)

This One



RJRH-4LO-LB24

THE HOME WORKSHOP

The Shipshape Home

(Continued from page 110)

used or in turpentine or kerosene. Another method is to leave a small amount of the paint or varnish on it and wrap it up in several thicknesses of newspaper. It can be kept soft for days by this method, which will not serve, however, for brushes used in shellac, alcohol stains or other quick-drying finishes.

Putting a brush in water to keep it from hardening usually is not considered good practice, though some painters do it.—A. J.

Priming
Woodwork

Successful painting of new woodwork depends partly upon using a priming coat that is adapted for the particular variety of wood being finished. Such woods as white and red cedar and California redwood absorb paint well, and the priming coats on them should have plenty of raw linseed oil. Each gallon of paint used for priming should have mixed with it from 1 to 1½ pints of raw oil and turpentine mixed in the proportions of two to one. The variable graining of these woods in respect to color makes it imperative that they should have three coats of paint.

White pine, whitewood, basswood, elm, and poplar absorb paint moderately well. The priming coat should be mixed with ¼ pint of turpentine to a gallon of paint. The color of these woods is sufficiently uniform to permit two-coat work, provided the paint is colored. With white paint three coats are necessary.

Listed as woods that are difficult to prime are yellow pine and other hard pines, the fir, spruce, hemlock, cypress and gum. The primer should be thin and penetrating. To each gallon of paint for priming at least one pint of turpentine should be added.

The second and third coats also should be thin and well brushed out. It is not advisable to attempt using only two coats on these woods.

Galvanized
Iron

To MAKE a really good job of painting galvanized iron, first wash it with a solution of 1 qt. warm water in which has been dissolved ¼ oz. each of nitrate of copper, chlorid of copper, and sal ammoniac, and to which ¼ oz. of crude hydrochloric acid has been added. The mixture should be made in a glass or earthen dish and applied with a flat brush. After it has dried, the powder remaining on the surface should be removed.

Give a first coat of red lead thinned with pure boiled linseed oil and a small quantity of turpentine and follow with two coats of a good white lead paint.

If the metal can be left standing unpainted for at least a year, it can be painted without any preliminary treatment except washing with sand-soap and water.—G. H. E.

Estimating
Paint

IN ESTIMATING the amount of paint required for painting a house, measure the distance around the building in feet, multiply that number by the average height in feet and divide by 350. This gives the number of gallons necessary for two coats.—M. F.



Thoroughbreds

Crack machinists, ambitious apprentices—the real thoroughbred mechanics of the metal-working arts—prize and demand the superior precision tool quality found only in

Starrett Tools

—the thoroughbred fine tools.

A typical example is the Starrett Micrometer Case No. 910, designed to meet the demand for a higher finished micrometer case. Nickel plated, round corners, velvet lined, it makes a fit setting for a splendid tool. Made for 1 inch micrometer only.

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Grinder and Buffer, with the above motor. Has 6 inch abrasive wheel and 7 inch Buff

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These extra tests assure you of getting the long, trouble-free service for which Vitalics are famous country-over.

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Why should anyone be content with cheaper tires when Vitalics cost so little more and out-wear two of the ordinary kind?

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VITALIC Bicycle Tires

Improved Fruit-Picking Ladder Lessens Danger of Slipping

TO MAKE a fruit-picking ladder that will slip between the branches easily and will give a more rigid and certain support than the ordinary ladder, build one like that shown in the accompanying illustration. It is simply a heavy pole, preferably of cedar, trimmed of bark with a drawknife and ripped up the center to within $2\frac{1}{2}$ or 3 ft.



One long pole forms the ladder leg

of the small end. At this point an iron band is placed to prevent the pole from splitting further while in use.

Holes are bored for the ladder rungs. It is easier to insure each pair of holes being exactly opposite if the boring is done before the pole is split.

Even when this ladder is placed against a limb that has a decided slope, it will not tip sideways, because of its wide base. It has the additional advantage of not breaking off so many fruit-bearing limbs when it is slipped among the boughs.—G. E. P.

Baby's Portable Play Yard Is Simply Constructed

MOTHERS like to have their babies play in the yard in good weather, but there is always danger unless some one is present to watch them or a play yard is provided.

This portable inclosure may be put together by a handy man for a few dollars. Four ordinary wooden frames are made

Corner rods
hold frames
together



of $\frac{1}{2}$ -in. material. These are carefully covered with screen-door wire netting. Two sheet-metal angle pieces are screwed to the end of each screen as shown. These are provided with holes to accommodate a $\frac{1}{4}$ -in. steel rod as shown. The rods pass through the angle-iron holes and hold the four screens together. The frames and even the screens can be painted any color desired.—J. B. M.

Ask to See This New Radio "B" Battery

Ask also to see the
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reception.



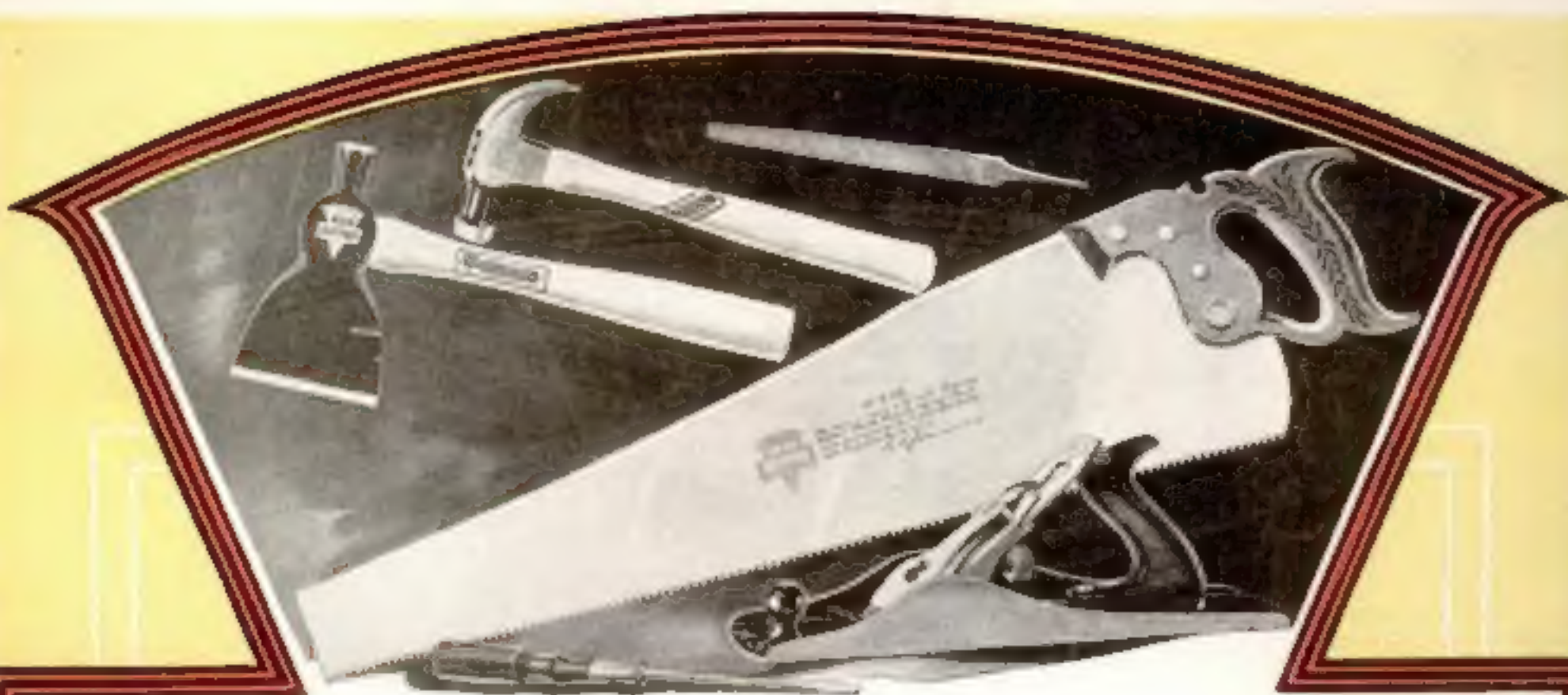
Ask your dealer or your nearest Willard Service Station to show you this specially designed 24-volt rechargeable Radio "B" Battery. Note the leak-proof glass jars—hard rubber screw-on covers—special Radio "B" plates—Threaded Rubber Insulation.

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